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THE UPPER ORDOVICIAN FAUNA
OF
FROBISHER BAY, BAFFIN LAND

BY
SHARAT KUMAR ROY
CURATOR OF GEOLOGY

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GEOLOGY, MEMOIRS
FIELD MUSEUM OF NATURAL HISTORY
VOLUME 2
SEPTEMBER 30, 1941



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PREFACE

The data and material upon which this paper is based were collected by me during the seasons of 1927 and 1928, while I was serving as geologist of the Rawson-MacMillan Expedition of Field Museum to Labrador and Baffin Land. The trip was a most profitable and enjoyable one and I wish to take the opportunity here to express my deep gratitude to the late Frederick H. Rawson and to Mr. Stanley Field, the sponsors of the expedition. Mr. Field, furthermore, took a deep interest in the progress and accomplishment of the expedition from the very outset. His frequent radio messages of encouragement and his inquiries as to the general well-being of the members of the expedition were a stimulating influence in our activities and doubtless exerted a strengthening effect on our morale.

I also take the opportunity to acknowledge here my indebtedness to Lieutenant Commander Donald B. MacMillan, U.S.N.R., who was in command of the expedition, and to Captain J. T. Crowell of Gloucester, Massachusetts, who was second in command and in charge of the trip to Frobisher Bay, Baffin Land. Born to the sea and ever watchful of its thousand hazards, they sailed the ship through the uncharted seas without a major mishap and conducted the activities of the expedition with commendable efficiency. I shall long and gratefully remember the consideration shown me by Commander MacMillan and Captain Crowell and value the experience I gained from my close and sustained contact with them.

In this connection I cannot forbear acknowledging my sincere appreciation to each and every member of the expedition for his sportsmanship and cheerful co-operation in all matters. I wish to thank particularly Messrs. Ralph Robinson and John Jaynes, who accompanied me to Silliman's Fossil Mount, Frobisher Bay, Baffin Land, and helped me to make the collection comprehensive as well as representative.

My chief task in the expedition was to collect fossils from Silliman's Fossil Mount and to make observations on the geology of the coasts that we were to visit. These objectives were attained, but I believe that a still greater measure of success might have been achieved if arrangements could have been made whereby it would have been possible to make more frequent landings and spend longer time in localities which were found to be particularly interesting from a geologic point of view. It must be clear, however, that, owing to the varied interests of the expedition, it was impracticable either to land oftener or to make longer stays in localities that were of interest to the geological personnel only.

There are advantages as well as disadvantages of an expedition representing different branches of natural history, and it remains a moot question whether or not the composite results obtained in such an expedition are commensurate with the losses sustained by individual branches. The point is a very important one for a museum, which, for its success, rightfully expects

every member of its scientific staff not merely to collect specimens for exhibits but also to secure adequate data of his observations for research, and for new fields of endeavor to be entered upon in the future.

The main subject matter of this memoir consists of the description and the determination of the stratigraphic range of the fossils collected at Silliman's Fossil Mount. I have, however, included at the beginning a chapter entitled, "Narrative of the Expedition with Notes on the Coastal Geology of Labrador and Baffin Land." This has been introduced to maintain continuity of observations, to give the reader a bird's-eye view of the expedition as a whole, and to bring out such incidents as have been thought to contain elements of general interest. Personally I believe that nothing is lost, and much is gained if incidents and episodes of human interest of an expedition are recorded along with the report of its scientific results, particularly if the expedition has been conducted in far-off and little known places.

I am fully aware of the fact that this paper should have been prepared and published earlier than this but I feel that I need not offer an apology for the delay. Until a little more than a year ago, when additional members were added to the staff of the Department of Geology, I had had no opportunity to devote the time needed for its completion. With the appointment of new members, I was relieved of much of the routine work and was thus, for the first time since I returned from the expedition, able to give my undivided attention to the preparation of the paper. My work was further facilitated by the splendid support I received from the Director of the Museum, Major Clifford C. Gregg, and from the Chief Curator of Geology, Mr. Henry W. Nichols. I wish to extend to both my sincere appreciation and heartfelt thanks. To Major Gregg I also owe a debt of gratitude for granting me leave to visit other museums and universities for the purpose of furthering my investigations in this connection, and for generously providing me with all needed equipment.

During my visits to other institutions I have called upon a number of geologists who, as authorities in their fields, have rendered me invaluable aid by checking over my identifications, by giving me access to their study collections for examination, and by discussing some of the controversial problems that have arisen from time to time. I wish especially to mention that everywhere I went I was met with unflinching courtesy and was given every assistance needed to make my visits profitable as well as enjoyable. My profound appreciation and gratitude are due to Dr. R. S. Bassler, of the United States National Museum, for his help in the identification of some of the difficult forms described in the sections of Bryozoa and Ostracoda; to Dr. Charles Schuchert, of Yale University, for giving me the benefits of his views on the fauna as a whole, and of his extensive knowledge of arctic stratigraphy; to Dr. E. O. Ulrich, of the United States National Museum, for checking over the identifications of Pelecypoda and Gastropoda and for discussing at length with me some of the more complex problems of correlations; to Dr. Josiah Bridge, also of the Geological Survey, for generously allowing me to share his office and for assisting me to find allied

species of gastropods for comparative studies; to Dr. G. Arthur Cooper, of the United States National Museum, for his valuable criticisms and suggestions for changes in the section on Brachiopoda and for making available to me the entire collection previously made at Silliman's Fossil Mount; to Dr. Percy E. Raymond, of Harvard University, for kindly going over my manuscript in the section on Trilobita and for directing me to references I had overlooked; to Dr. A. K. Miller, of the University of Iowa, for assisting me in the identifications of cephalopods, for reading the description of nearly every species, and for the courtesies and facilities he extended to me during my stay at Iowa City; and finally, to Dr. Carey G. Croneis, of the University of Chicago, for the patient and laborious work of reading the entire manuscript and for making numerous suggestions and alterations. This paper could not have appeared in its present form without the personal interest taken by Dr. Croneis. For this, and for his constant encouragement and sympathetic helpfulness, I offer him once again my most sincere and hearty thanks.

I am also obligated to Dr. G. Marshall Kay, of Columbia University, for explaining to me some of the questions relating to the "Ordovician Stewartville-Dubuque Problems," and to Dr. H. E. Vokes, of the American Museum of Natural History, for the loan of specimens previously collected by Mr. R. W. Porter at Silliman's Fossil Mount.

My colleagues, Messrs. Bryan Patterson, Paul McGrew, and Henry Herpers, have helped me in many ways. Mr. Patterson has read a greater part of the manuscript and has made valuable suggestions. Mr. McGrew and Mr. Herpers have assisted in the preparation of photographs of microfossils and of certain specimens requiring the use of special techniques. It is my pleasant duty to extend to them my very sincere appreciation.

The manuscript was typed, in part, by my assistant, Mr. Henry Horbeck, and completed by Mrs. Corine Mintrop. I wish to thank them for their labors.

As in all Field Museum publications, the responsibility of editing the manuscript and seeing it through the press has fallen upon the Staff Editor, Miss Lillian A. Ross, to whom my grateful thanks are due. The task of editing the memoir has been particularly difficult and Miss Ross is to be commended for her painstaking efforts to give the volume an attractive dress.

The pictorial photographs were taken by various members of the expedition and the greater part of the photographs of fossils by the Staff Photographer, Mr. C. H. Carpenter. The drawings and retouchings were the work of Staff Illustrators, Mr. Carl F. Gronemann and Mr. John J. Janecek. The collotype reproduction of all figures was by the Staff Collotyper, Mr. A. A. Miller.

In conclusion, I wish to add that although I have received invaluable aid by various authorities and have guarded to the best of my ability against errors, there must still be some which have escaped my attention. For any errors that may exist I alone am responsible.

NARRATIVE OF THE EXPEDITION
WITH NOTES ON COASTAL GEOLOGY
OF LABRADOR AND BAFFIN LAND

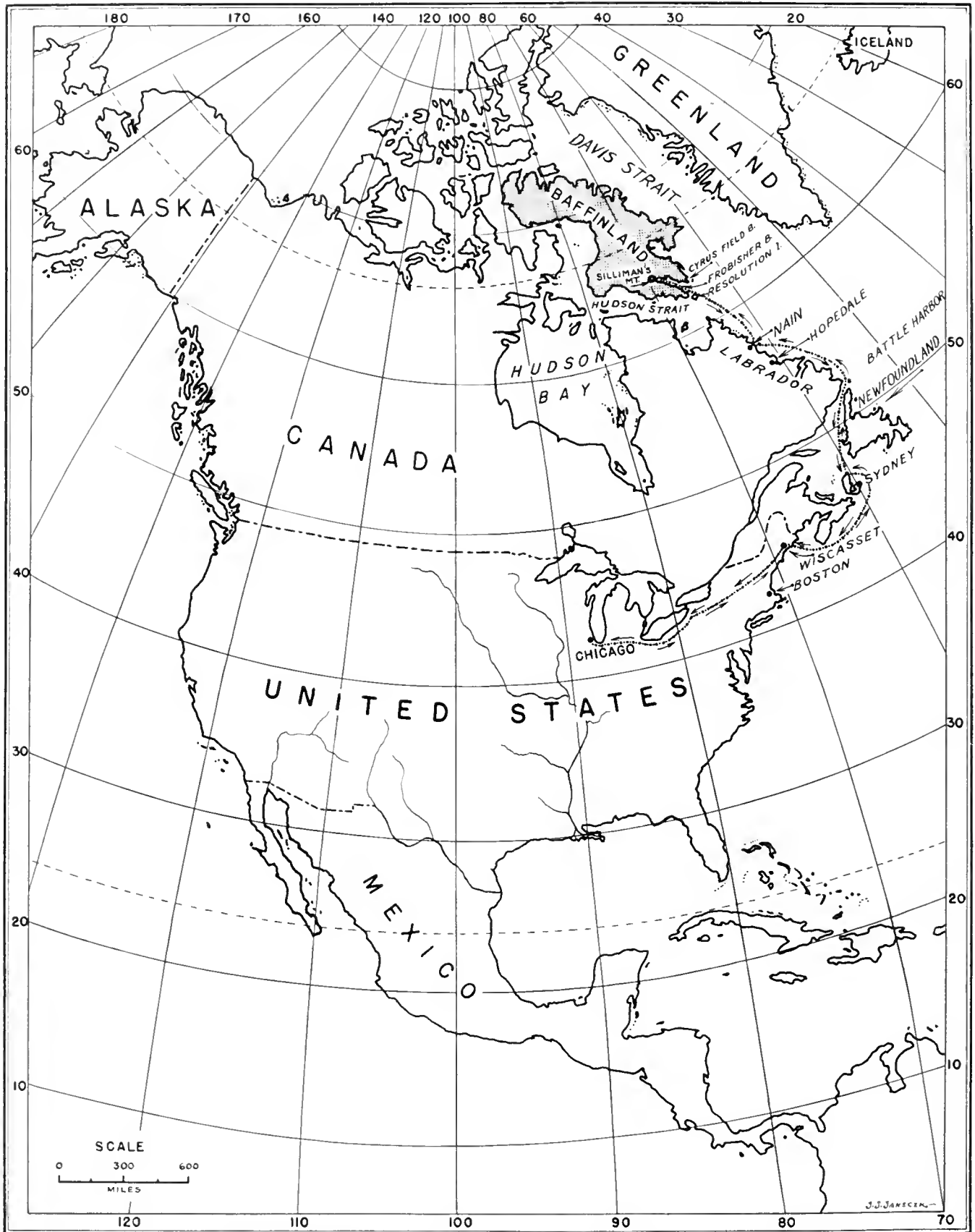


FIG. 1. Map showing route of Rawson-MacMillan Expedition of Field Museum to Labrador and Baffin Land.

NARRATIVE OF THE EXPEDITION

INTRODUCTION

The expedition was organized to spend two summers and a winter (June, 1927–September, 1928) cruising the coastal waters of Labrador and Frobisher Bay, Baffin Land, with headquarters at Anatalak Bay, about twenty miles northwest of Nain, Labrador. The object was to make extended observations and collections relating to anthropology, botany, geology, and zoology, for Field Museum.

The personnel was composed of fifteen men: Lieutenant Commander Donald B. MacMillan, in charge; Captain J. T. Crowell, in charge of the trip to Frobisher Bay; Ralph Robinson, mate; Frank Henderson, second mate; John Jaynes, engineer; E. K. Langford, surgeon; Clifford Hymoe, radio operator; Martin Vorse, cook; Abie Broomfield, Eskimo interpreter; Charles Sewall, botanist; Novio Bertrand and Arthur G. Rueckert, taxidermists; Alfred C. Weed, ichthyologist; W. Duncan Strong, anthropologist; and Sharat K. Roy, geologist. The last four members were from the staff of Field Museum.

The means of transportation consisted of three boats and a snowmobile. Of the three boats two were schooners, the *Bowdoin* and the *Radio*, and one a 35-foot cabin cruiser, the *Seeko*. The snowmobile was used for travel over frozen waterways during the winter.

To those contemplating an expedition to Labrador or farther north, it may be helpful to point out that various villages on the coast of Labrador, as far as Nain, may be reached for about three months, usually from July to September, by means of coastal steamers. The movements of the steamers, however, are irregular and cannot always be depended upon. There are no boats available at any time that will carry passengers to Baffin Land. An expedition intending to explore that region must provide its own means of transportation.

FORTEAU BAY: RAISED BEACHES AND GLACIAL STRIAE

We sailed from Wiscasset, Maine, on June 25, 1927, and reached Sydney, Nova Scotia, three days later. Here we took on 28,000 feet of lumber for our winter station and left for Battle Harbor, Labrador, on July 6; but, before we could reach our destination, heavy fog forced us to take shelter in Forteau Bay on the southeastern shore of Quebec in the Gulf of St. Lawrence. The bay is bordered by a magnificent raised beach of the wave-cut terrace type. Raised beaches of this kind, which, so far as known, are all of postglacial age, were later found at almost every bay and inlet along the coast of Labrador. They occur at various heights above the present sea-level and furnish a striking proof of the recent emergence of the land. In general, the elevated shore-lines in the St. Lawrence Valley are higher than those observed northward along the Labrador coast. This observation seems to indicate that the Labrador ice-sheet was relatively thicker to the south; and hence, that region, because of the greater

weight of ice, was more depressed. At Forteau Bay, erratic boulders of granite and pegmatite of glacial origin were found in great abundance on the terraces, particularly on those at higher levels. Glacial markings, indicating southeastern movement of the ice, were observed on bare ledges above the terraces.

ICEBERGS

On the following day (July 7), with the first sign of clear weather, we got under way and soon fell into the Strait of Belle Isle. It had been an unusual summer. There was little or no floe ice to be seen, but the ocean seemed packed with hundreds of icebergs (Fig. 3) of every size and description—more than had been seen in any one season within the memories of the oldest inhabitants. The icebergs were derived almost entirely from the Greenland ice-cap, chiefly through the calving of three large glaciers, Jacobshavn, Torsukatak, and Garajag (pronounced Karaiak), which descend into the sea on the west coast at a latitude approximately 70° N., between Christianshaab and Umanak. Once free, the icebergs find their way to the open sea and drift southward with the Labrador Current along the coasts of Baffin Land and Labrador, then along the east coast of Newfoundland to the Grand Banks and the routes of the transatlantic liners. The average rate of drift, if not slowed down by floe ice, is about ten miles per day. The journey south, however, is not an easy one, for large numbers of the icebergs meet destruction on the way, either by becoming grounded or by being stranded along the coast. Those that survive the trip and become an actual menace to transatlantic navigation are comparatively few.

BATTLE HARBOR AND ASSIZES BAY: LITHOLOGY AND GLACIAL STRIAE

At dawn on July 8, Battle Harbor, Labrador, was sighted. We steamed past it and anchored in Assizes Bay. Now, for the first time, we encountered the dreaded mosquitoes and black flies. It is well to emphasize here that they are far more formidable a menace than is usually believed. Although we were equipped with the best-known protections against these horrible pests, none proved equal to the situation. Of the two evils of the North—mosquitoes and flies in summer and bitter cold wind in winter—the latter is by far the more bearable.

The rocks around Assizes Bay are predominantly metamorphics—contorted gneisses and schists, cut extensively by quartz, granite and diabase dikes. Slightly altered granites and diorites and a basic rock composed chiefly of hornblende, probably hornblendite, are also present in large masses. Glacial striae having a general southeast direction are common on outcrops at the hilltops.

AILLIK BAY: LITHOLOGY, GLACIAL STRIAE, AND LUNOID MARKINGS

We continued our journey northward and, after calling on the way at Spotted Island, Isle of Ponds, Gannet Island, Indian Harbor, and Aillik Bay,

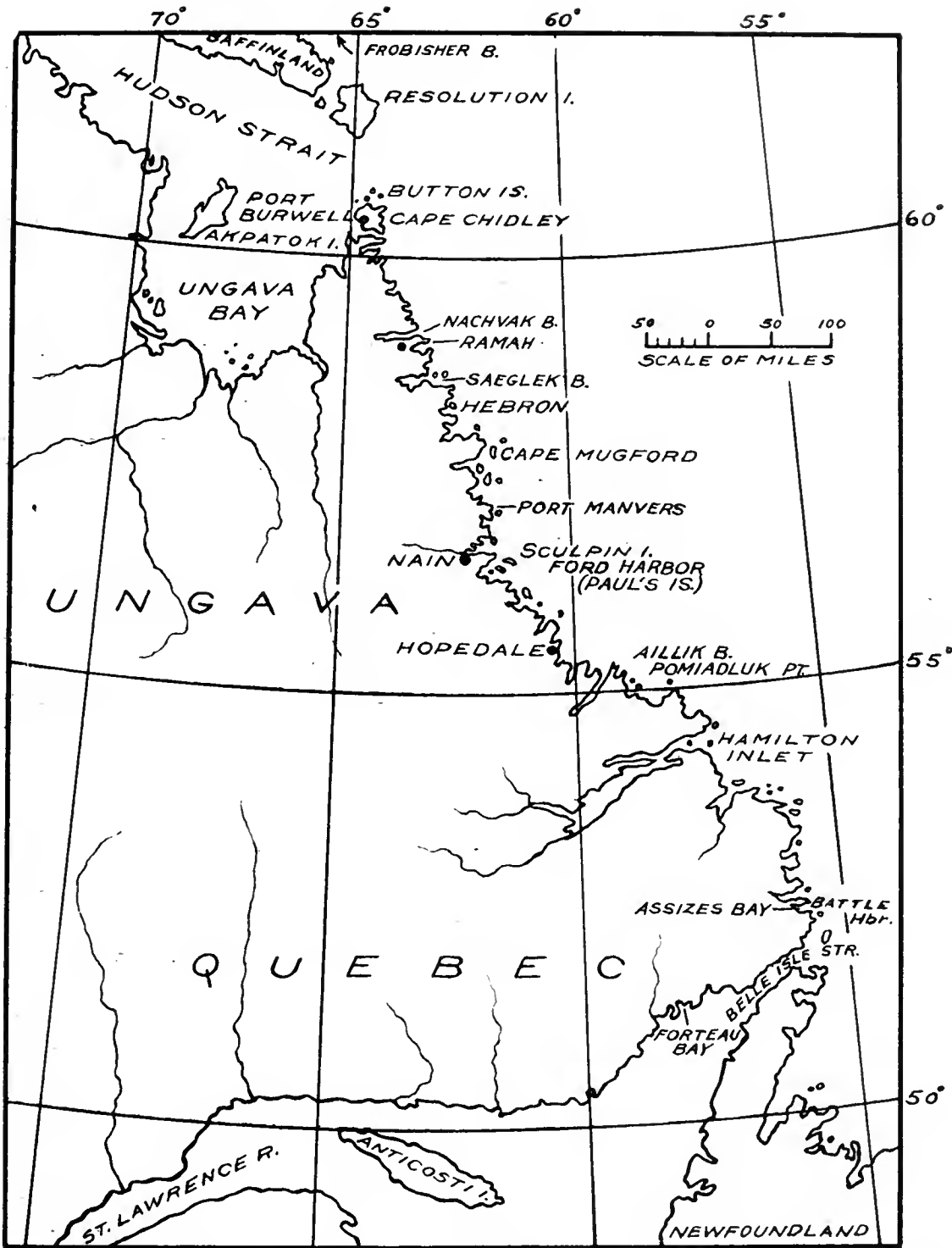


FIG. 2. Sketch map of Labrador coast showing approximate positions of villages, some of which were visited by the members of the expedition.

reached Hopedale five days later. From a geologic point of view, the region around Aillik Bay is of more than usual interest. The bay, which trends in a northeast-southwest direction, is some five miles long and about a mile wide, and has excellent coves for safe anchorage. It is surrounded by high ridges composed of rocks very similar to those observed in Assizes Harbor. At the base of these ridges, not far from the beach, lies a second ridge—a belt of quartzite dipping toward the mainland. The belt is not continuous. It is narrow—about one hundred feet thick—and terminates at the mouth of the bay, where both of its ends are cut off by massive gneissoid granites. The quartzite is strikingly banded, shows cross-bedding in places, and is traversed by numerous dikes of both acid and basic rocks. No fossils were found in the quartzite, but apparently the formation is younger than the crystalline rocks which it overlies. Metamorphosed conglomerates and quartzites are also found at Pomiadluk Point, about sixteen miles southeast of this area, but it is not known whether or not these rocks are contemporaneous with the Aillik Bay quartzite. We had no opportunity to go ashore at Pomiadluk Point and consequently no studies bearing on the relationships between the two quartzites could be made.

The direction of the ice-movement in the vicinity of Aillik Bay, as indicated by the striations, appears to have been northeast. Associated with the striations, groups of well-formed lunoid markings were observed. These crescent-shaped markings are thought to have been the result of tension set up in the bed-rock at the gouging corner of an angular boulder caught in the advancing ice. They have been seen and discussed by practically every geologist who has visited the Labrador coast. Further discussion of their origin seems unnecessary, particularly since no experimental data are at hand.

LABRADOR ESKIMOS AT HOPEDALE

Before we were halfway into the harbor of Hopedale, the Eskimos came paddling out in kayaks (Fig. 4) and swarmed up our boat's ladder like a group of excited children. For friendly spirit, good faith, and sportsmanship it is difficult to match the Eskimo's character. Unfortunately, his future does not seem promising. His contact with civilization appears to have done him more harm than good. Venereal and pulmonary diseases are widespread and have visibly affected his health and spirit. This is especially true of the Labrador Eskimo.

ROCHES MOUTONNÉES AND ROCK BASIN LAKES

Hopedale, the seat of a Moravian mission established in 1782, is situated at the head of a wide bay. Terraced, rounded hills, having a general *roche moutonnée* form (Fig. 4), with small lakes (Fig. 5) located on or among them, constitute the major features of the landscape. The bed-rock is predominantly gneiss, but more severely contorted, sheared, faulted, and injected by dikes than that heretofore observed. At various places on the surfaces of *roches moutonnées*, glacial striae indicating a northeasterly movement of the ice, and lunoid markings in groups, are of common occurrence.



FIG. 3. Icebergs on the coastal waters of Labrador. They were derived almost entirely from the Greenland ice-cap.

NAIN

Piloted by Eskimos through narrow, circuitous inlets among a maze of islands, locally known as the "inside run," we headed for Nain and dropped anchor there the following noon. Perched above a valley rimmed by high



FIG. 4. Left, *roches moutonnées* at Hopedale, Labrador; right, Eskimos paddling out in kayaks.

hills, Nain commands a picturesque view. It is the oldest Moravian mission station in Labrador, dating back to 1771.

NAIN ANORTHOSITE

In approaching the vicinity of Nain, a striking change from the prevailing gneiss to anorthosite becomes apparent in the character of the bed-rocks. The abrupt change begins at Paul Island, in Ford Harbor, a few miles directly east of Nain, and continues uninterruptedly northward, at least to Port Manvers. Like the Hopedale gneiss, the Nain anorthosite is cut rather extensively by dikes of aplite, granite, and pegmatite. In places the anorthosite contains large masses of pure labradorite of gem quality. As a rule, the labradorite is more coarse-grained than the country-rock, but there are no indications which suggest that the two were not formed contemporaneously. In reflected light, the mineral shows a brilliant display of color, and because of this it has long attracted the attention of the natives. Its occurrence, however, was not known to the outside world until 1770, when samples of it were collected by a Moravian Brother from Paul Island and shipped abroad for possible use in the gem indus-

try. In recent times, it was quarried on a large scale by Mr. R. G. Taber on Napotlulagatsuk Island, between Paul Island and the mainland, about twelve miles east of Nain. The enterprise, however, was not successful. The failure was attributed to the difficulty of getting out large slabs intact. Due to the



FIG. 5. Rock-basin lakes in the vicinity of Hopedale, Labrador.

complicated cleavage system that the mineral possesses, much of the material was shattered during the process of quarrying it.

SCULPIN ISLAND: DRIFT FOSSILS

Soon after our arrival at Nain, the work of the expedition fell into routine. At Anatalak Bay, twenty miles northwest of Nain, a site on which to build our winter quarters (Fig. 27) was selected. It was an ideal location for our purpose, since we did not have to contend with the problems of obtaining either water or firewood. A nearby mountain brook and surrounding woodlands of spruce and balsam fir supplied us plentifully with both (Fig. 17). While the house was being built, we took turns making a number of excursions to the neighboring islands. Of these, the trip to Sculpin or Kanaiotok Island, about twenty-one miles northeast of Nain, was perhaps the most productive. It is commonly believed that this island was settled by Norsemen some nine hundred years ago and that the ruins found there might be Norse. A survey of the ruins and examinations of the artifacts, however, led our anthropologist, Dr. William Duncan Strong, to conclude that the site represents an Eskimo spring or autumn camp of the Thule culture rather than an early attempt at colonization by the Vikings. On this island twenty-two drift fossils representing four genera and

six species (*Hormotoma labradorensis* Roy, *Hormotoma minuta* Roy, *Turritoma* cf. *T. ada* (Billings), *Helicotoma rawsoni* Roy, *Bathyurus sculpinensis* Roy, and *Bathyurus*(?) sp. were found (Fig. 6). They clearly compose a typical Upper

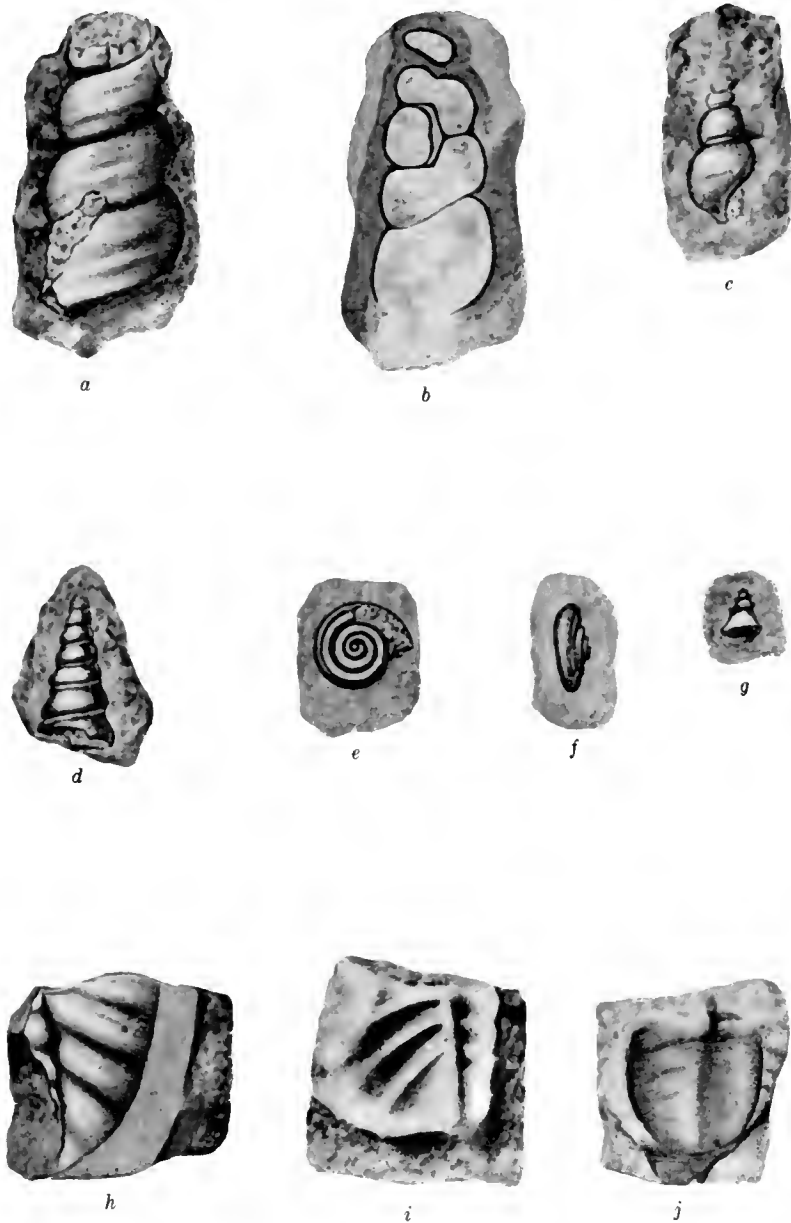


FIG. 6. Upper Canadian (Beekmantown) drift fossils from Sculpin Island, near Nain, Labrador. a, b, *Hormotoma labradorensis* Roy; c, *Hormotoma minuta* Roy; d, *Turritoma* cf. *T. ada* (Billings); e, f, g, *Helicotoma rawsoni* Roy; h, i, *Bathyurus sculpinensis* Roy; j, *Bathyurus*(?) sp.

Canadian fauna of the American Atlantic phase, hitherto not found in the American arctic or eastern subarctic regions, and indicate a much wider distribution of the northern Canadian faunas than was heretofore believed. (For a more complete discussion of the subject, see Roy, 1932.)

GLACIAL STRIAE AND BOULDER REEFS

Glacial striae, indicating a northeasterly movement of the ice, were observed in some of the outer islands north of Ford Harbor, but none of the lunoid markings, so well developed along the southern coast, was seen. Judging from the general direction of the glacial striae—southeast, east, and northeast—thus far observed at Forteau Bay, Assizes Harbor, Aillik Bay, Hopedale, and in the neighborhood of Nain, it is apparent that the ice moved outward from a center



FIG. 7. Boulder reef, near Nain, Labrador. Most of the boulders are of glacial origin. Photograph by E. P. Wheeler II.

of accumulation. An unusual feature of the glacial geology of the southern coast of Labrador is the scarcity, commonly the total absence, of drift deposits. With the exception of erratics on raised beach terraces and small isolated deposits of till, no other deposit of glacial origin was observed. A type of deposit which consists predominantly of glacial boulders but which cannot be termed a glacial deposit was observed along shores of certain bays and islands in the vicinity of Nain. This type of boulder formation is commonly called a "boulder reef" or "boulder barricade" (Fig. 7) and is found at distances ranging from a few feet to 150 feet from the shore, where the gradient is moderately steep, to a short distance below low tide. The way in which such deposits are formed is not clearly understood. According to Daly they are the result of the combined work of tide, undertow, surf, and landfast ice, during and after the postglacial uplift of the land. Daly's interpretation, which appears to be a very plausible

one, is as follows (Daly, 1902, pp. 260-261): "As the land emerged, the boulders (from the wave-swept zone immediately above) were dragged down in the undertow and lodged just below the level where surf could move them. The relative absence of boulders between the shore and the barricade is also explained in part by the action of coast ice, which floats off such boulders when the ice-foot breaks up. If the boulders happened to be dropped again just at the limit where, on account of the depth, the surf is no longer effective in moving boulders resting on the bottom, the erratics would further build up the wall constructed by the undertow. Very close to that limit of effective wave-wash, the winter ice, because of the depth at which the boulders lie (submerged at high tide), would not be able to buoy up the heavy masses and float them away."

NASKAPI INDIANS

Apparently, news of our arrival in Anatalak Bay reached the Naskapi Indians. One evening, three dark specks appeared across the bay. Soon paddles could be seen flashing as the copper-skinned crew drew closer. Rarely, in North America today, can one get the thrill that comes with the first sight of a Naskapi, for the Naskapi are truly wild Indians, living by the hunt as their ancestors did before them. From Northwest River to Ungava Bay, and extending inland for more than a hundred miles, is an unexplored area of 300,000 square miles entirely unoccupied save by one hundred Indians. No reservations confine their movements and the vast interior is their hunting ground.

The lot of a Naskapi, however, is not a happy one. Hard as his life is in summer, beset by the dreaded insects as he portages his canoe over long muskogs from one waterway to the next, his winter life is even more precarious. The lakes, ponds, and rivers are many feet thick with ice, and the animals, none too abundant in summer, seem now to have utterly vanished. On snowshoes, the hunter wanders (Fig. 8) day after day on the lookout for such caribou as the Caribou God may send in answer to his prayers. If night finds him on the Barrens, he may burrow in the ground, build a huge fire and alternately sleep and feed the fire; or else he may heap up a pile of snow, let it freeze and hollow it out with a snowshoe to form a cave, which, sealed tightly, will let him pass the bitter night in comparative warmth.

When the caribou are not to be found the Indians starve; often the men drop in their tracks while roaming the desolate and endless Barrens looking for game where there is no game. But the menace of lonely land and an uncertain food supply does not depress the Naskapi, who have always faced such odds. "Sufficient unto the day are the evils thereof," is a sentiment wholly in keeping with Indian psychology. When there is meat, there is continuous feasting; when there is no meat, there is no complaining.

TO FROBISHER BAY, CAPE MUGFORD, HUDSON STRAIT, AND RESOLUTION ISLAND

Our trip to Frobisher Bay, Baffin Land, was considerably delayed because of lack of information regarding ice conditions in Davis Strait. Finally, on



FIG. 8. Top left, a Naskapi Indian in traveling gear; top right, hunting ptarmagin. Bottom left, MacMillan showing to a group of Naskapis pictures of North American Indians; bottom right, a Naskapi fishing through ice.

August 7, we received favorable news and got under way the following day before sunrise. Steaming through the calm waters of the "inside run" to Port Manvers, we swung north to the open sea. The shadow of the iron-bound coast with perfect images of the sentinel-like cliffs of the Kiglapait Range fell far over us out at sea. This range is some twenty-five miles long, its axis running approximately parallel to the coast-line. Almost immediately after we had passed the Kiglapait, Cape Mugford loomed up in stately grandeur. Three thousand feet of metamorphosed sediments and intercalated diabase sills rose straight out of the sea. The metamorphosed rocks, consisting chiefly of slates, quartzites, and altered agglomerates, lie unconformably over some five hundred feet of irregularly eroded gneisses and schists. It is much to be regretted that we could not spend a longer time here, for besides being one of the grandest bits of scenery in North America, this region offers a splendid opportunity for geological exploration and research.

Dusk fell as we rounded the cape. During the night, we passed by Hebron, Saeglek Bay, Ramah, and Nachvak Bay and so saw little of this section. Early in the morning, the bleak, forbidding countenance of the Torngat, aptly called the "Evil Spirits" by the Eskimos, appeared in the distance, but our course kept us too far offshore to get a clear view of this ragged chain of mountains. It is believed that the continental ice-cap did not cover the Torngat and that its Alpine character has been preserved from pre-glacial times.

As we passed Cape Chidley, the northernmost tip of Labrador, and entered Hudson Strait, the air became colder and the sea rougher. The tide was exceptionally strong, and we could make but little headway. At times, we were actually driven backwards. During the night, a strong southeasterly wind shrieked viciously, tearing the tops of great waves into a haze of driving spray. A succession of seas broke full on the stern and tons of icy water poured in a roaring torrent, filling the deck high above the hatches. The little ship staggered and quivered but shook herself clear. At daybreak, a heavy fog came down with incredible rapidity, blotting out our view of Resolution Island¹—our only land mark. Squalls of sleet and sudden snow flurries scoured down at intervals. Huge waves thundered against uncharted reefs, sending up great clouds of spray, and a seemingly endless stream of icebergs loomed up ghost-like through the mist, too close to the ship for comfort. Tide and cross-currents drove us off our course, and for a time we were completely lost in the maelstrom. So small was our ship and so great were the seas that it took all the strength of the helmsman to keep the wheel from spinning. Realizing our predicament, we veered east to seaward and hove to, rising and falling on the unbroken swell, until the fog lifted. There was still some daylight left when we entered Frobisher Bay, Baffin Land, and anchored in Jackman's Sound on the northwest coast of the bay.

¹ Since then Resolution "Island," situated at the entrance of Hudson Strait (Lat. 61° 31' N.; Long. 65° W.) with an area of about 1,600 square miles, has been partially explored and found to be not one island but a group of islands.

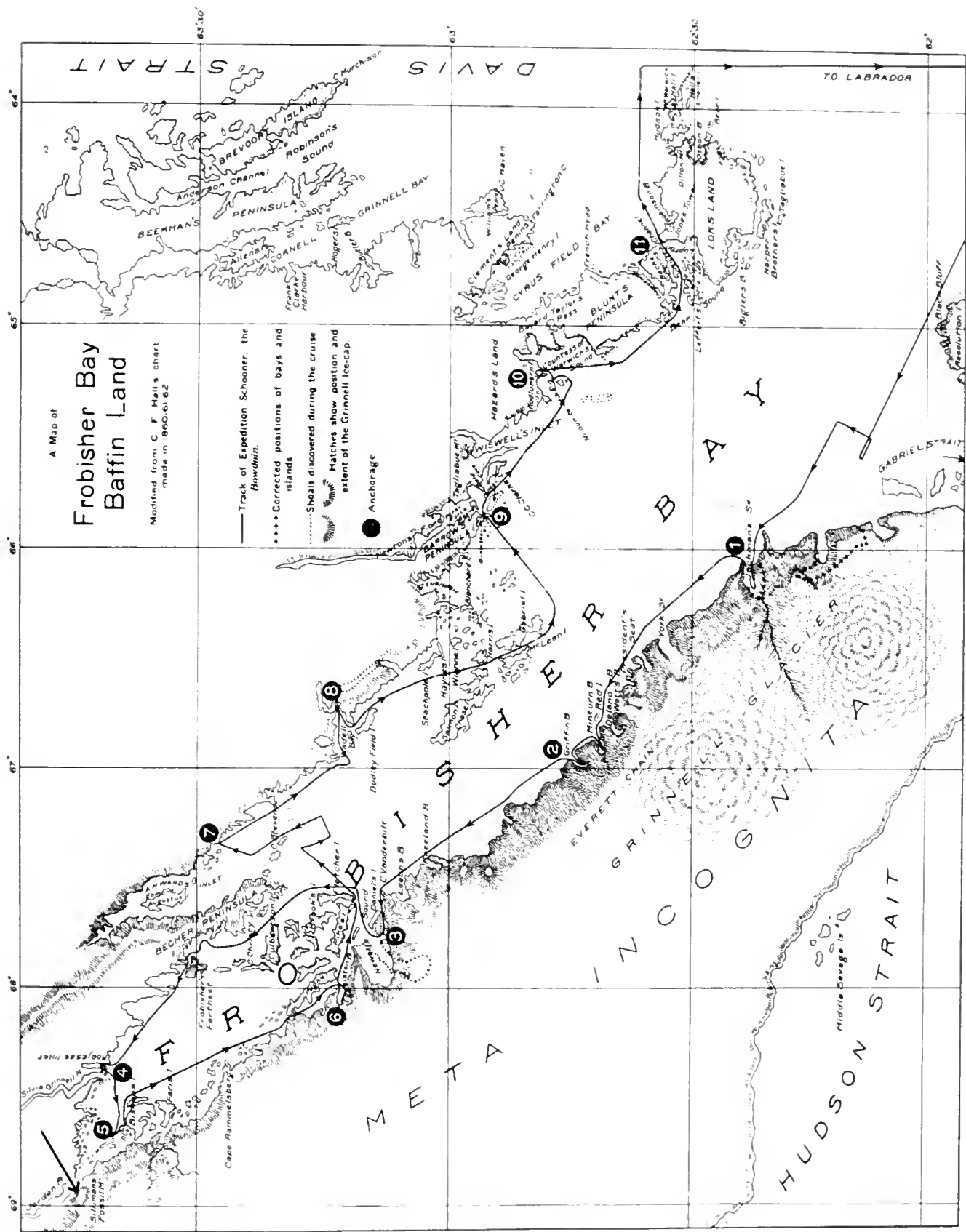


Fig. 9. Frobisher Bay, Baffin Land.

FROBISHER BAY: TIDES

Frobisher Bay (Fig. 9), a westerly arm of Davis Strait, is located at the southern extremity of Baffin Land, between Hudson Strait and Cumberland Sound. Its entrance, which is about 55 miles wide, is bounded on the north by Lok's Land and on the south by Resolution Island. The bay extends in a general northwesterly direction for about one hundred and fifty miles and contains numerous islands, reefs, ledges, and shoals. The upper part of the bay is divided into two arms: Ward's Inlet to the northeast, and the headwaters of the bay itself to the northwest. The intervening land between these two arms is known as Becher Peninsula. Northwest of the peninsula, the bay receives two good-sized rivers, the Jordan and the Sylvia Grinnell, the former emptying directly into the head of the bay and the latter twelve miles west of it. In their physical characteristics, one is a counterpart of the other, each having similar widths, gradients, and valley walls. In addition to these two rivers, there are several smaller ones but none of them seems to have played an important role in developing the configuration of the coast line. West of the valley of the Jordan, on the side of the Meta Incognita or the Kingaite, as the Eskimos call it, stands Silliman's Fossil Mount, a table-topped ridge of limestone and the only limestone deposit in the entire region surrounding the bay (see p. 42) to be seen *in situ*. In general, the topography on both sides of the bay is high and rugged, and both shores are indented with numerous fiords and long winding inlets. Of the two, however, the coast of Meta Incognita (west coast) is considerably higher, bolder, and more severely dissected. It harbors on its southwest side a sizeable ice-cap (see p. 34) and small mountain glacierets.

The tides in the bay are exceptionally high, varying from twenty-four to forty-eight feet. This tremendous rise and fall is a serious menace to navigation, particularly because the bay has never been surveyed hydrographically. Ordinarily, the safest time to travel in the bay is at periods of low tide. During times of high tide, numerous low islands become submerged, making passage extremely hazardous. Low tide is also the safest time to look for anchorage. Once, as a result of anchoring at high tide, we came close to experiencing what might have been the end of the expedition, for when the tide ebbed, the water dropped six fathoms, leaving the boat high and dry with her masts canted at an angle of thirty degrees. Tides and rocky shoals, however, are not the only obstacles; the region is notoriously stormy and is obscured by fog much of the time.

VOYAGES OF SIR MARTIN FROBISHER

Frobisher Bay, long believed to be a strait connecting the Atlantic and the Pacific oceans, was discovered in 1576 and named in honor of its discoverer, Sir Martin Frobisher (Fig. 10), an English navigator and explorer. He is credited with being the first to venture the American Arctic, having pressed westward before Hudson and northward before Davis. Between the years 1576 and 1578, he commanded three voyages of discovery to the Arctic under the patronage of Queen Elizabeth. On his first voyage, in search of the Northwest Passage to China, one of his sailors picked up a black rock resembling coal, near what is

now known as Hall's Island, at the north end of the entrance to Frobisher Bay. To test its combustible qualities, the wife of the sailor who brought it home threw it into fire, where, instead of burning like coal, it "glistened with a bright marquesset of golde." The story of the incident soon spread and the stone was turned over to an alchemist, Baptista Angello, for identification. He declared that the sample contained gold and produced a few grains purporting to have



FIG. 10. Sir Martin Frobisher, discoverer of Frobisher Bay, Baffin Land.

come from it. On the strength of this statement, Frobisher raised money enough to lead two more expeditions and brought back to England a total of 2,100 tons of black rock—800 tons on the second voyage and 1,300 tons on the third. The "ore" (see p. 48), however, proved worthless and Frobisher was at once besieged by angry investors demanding an explanation. He had none to give, but escaped being heavily compromised through the intervention of the Queen, who not only absolved him of all charges but further redeemed his name from any obloquy by giving him the command of a ship of the Royal Navy. Later, Frobisher commanded the *Triumph* against the Armada and defended his ship with astound-

ing daring against a vastly superior strength. Because of this he was knighted by the Lord High Admiral. He died in 1594 from a wound received in action against the Spaniards off Brest.

THE DISCOVERIES OF CHARLES F. HALL

Frobisher's geographical achievements were practically lost to the world until the year 1861. That year an American naval officer, Captain Charles F. Hall, who was seeking possible survivors of Sir John Franklin's ill-fated expe-



FIG. 11. Jackman's Sound, Frobisher Bay, showing raised beaches. Photograph by M. J. Buerger.

dition, visited Frobisher Bay, then known as Frobisher Strait. He reached its headwaters, and found that the "strait" was but an enclosed arm of the sea and not the famous Northwest Passage to China, as Frobisher had supposed. On his return journey from the head of the bay, Hall accidentally stumbled upon evidences¹ of Frobisher's third voyage, at Kodlunarn Island, in Countess of Warwick Sound. At that time he was not familiar with Frobisher's voyages but he made a thorough search of the ruins (see p. 48), which he later found were linked inseparably with the activities of Frobisher.

The place names in and around Frobisher Bay were given entirely by Hall and Frobisher. Hall also made an outline geographical map of the bay—the only one ever made of the region. This map, which accompanies his book

¹ On his third voyage, Frobisher brought with him one hundred miners and assayers who were to establish a colony on Kodlunarn Island and build a fort to guard the "gold deposits" against the natives. The attempt failed but the foundation of a small house was laid to see what effect the climate would have on it by the ensuing year. Apparently, Frobisher contemplated a fourth voyage.



FIG. 12. Top, the Grinnell Ice-cap; bottom, a tongue of the ice-cap. Bottom photograph by M. J. Buerger.

“Arctic Researches and Life among the Esquimaux,” is most helpful as a general guide, but it contains many inaccuracies due to the fact that it was prepared from sights, the greater number of which were taken from across the bay and that, too, in the winter, when the snow covered both ice and land.



FIG. 13. Echelon crevasse of the Grinnell Ice-cap. Photograph by M. J. Buerger.

JACKMAN'S SOUND, GRINNELL ICE-CAP, AND EVERETT RANGE

Jackman's Sound, our first anchorage in Frobisher Bay, is in Lat. $62^{\circ} 22' N.$, Long. $66^{\circ} 10' W.$ It is wider and longer than is shown on Hall's map, and shoal water extends nearly a mile offshore. The shoaling is very abrupt, and there is a real danger of running aground.

The head of the sound or bay is bounded by a series of wave-cut raised beaches of varying heights (Fig. 11). The highest one is about 180 feet¹ above the level of high tide, indicating that Baffin Land has risen out of the sea to at

¹ Calculated by Dr. M. J. Buerger in a later (1937) expedition to Frobisher Bay (Buerger, 1938).

least that height since Pleistocene time. Back of the beaches is a wide valley that extends in an east-west direction for several miles and forms a transverse pass, dividing the Grinnell Ice-cap into two separate units. The valley is filled with fluvio-glacial deposits and is probably an elevated outwash plain, now trenched almost down to sea-level by a good-sized stream which, following a slightly sinuous course, empties into the bay, cutting through the beaches at the south end.



FIG. 14. Left, walking over Grinnell Ice-cap; right, rough ice and numerous crevasses.

During the two days we were fogbound in this place we made several attempts to study the ice-cap, but with little success. Ascending the hills to the southeast we reached the ice-cap (Fig. 12), but the visibility was so poor and the ice was so slippery and so full of crevasses (Figs. 13, 14) that walking without the aid of crampons proved impracticable.

On the morning of August 12, without waiting for the weather to clear, we raised anchor and sailed northwestward toward the head of the bay, keeping as close to the shore as safety would permit. The coastal range presented one unbroken line of jagged cliffs (Fig. 15), averaging at least two thousand feet in

altitude. Farther up the bay, at remarkably regular intervals, tongues of the ice-cap forced their way to the water's edge (Fig. 12). Several of these were seen, but none was very high or very thick. The largest one, having a frontage of about four hundred feet and a height of about two hundred feet, was found in Watt's Bay, just past President's Seat in the Everett Range. This bold chain of mountains, with its mantle of perpetual ice, numerous cirques (Fig. 15), tarns, arêtes, and serrated peaks towering high above the surrounding hills, lends to the coastal topography an air of rugged magnificence that cannot be surpassed in all of eastern North America. The ruggedness is obviously the result of destructive work by the numerous ice-tongues and of quarrying and frost-weathering by the many snowdrifts and glacierets harbored by the fretted upland.

GRIFFIN BAY: INLAND TOPOGRAPHY

We tried to reach the ice tongue in Watt's Bay but the sea was still very heavy and we could not effect a landing. Late in the afternoon we entered Minturn Bay (Fig. 16) but could find no anchorage with a hundred-fathom chain within a quarter mile from shore. At dusk we entered Griffin Bay. This is also a deep bay with no good anchorages. Hunting about for some time, we finally anchored at the mouth of a small stream on the south side near the head of the bay and moored to cliffs with quarter lines. Behind our anchorage, separated only by a narrow neck of land, we found a large glacial lake (Fig. 16). It is roughly L-shaped and forms the terminus of a glacial trough which extends inland for many miles to the southwest. The water level of the lake is a foot or less above the high tide, so that at high tide, when accompanied by a strong northwest wind, the sea water enters it and at three-quarters tide the lake water rushes out over the neck of the land like a miniature waterfall.

Taking advantage of fair weather, we worked our way inland over the glacial trough for a distance of four miles or more, and for the first time got a good view of the interior (Fig. 17). It is difficult to conceive of a more bleak and desolate country. Low, rounded, snow-capped hills rose one beyond the other until lost in the mist of tundra lands. Not a twig, not a shrub relieved the monotony of the incredibly barren landscape. As to the ice-cap, we had already passed it. From the summit of a high hill facing southeast, we could see a portion of it lying in a southeast-northwest direction, some four miles away. Its advance on the coast appeared checked by the bold walls except at a few flanks where it was finding its way to the sea. We had, however, no way of judging its extension into the interior, for the bordering line of extension was completely obscured by clouds of vapor rising out of the surface of the ice.

GRINNELL ICE-CAP

Since our visit to Frobisher Bay, three other parties have explored this ice-cap, each gathering additional data. Piecing these together, it has been possible to construct a fairly complete picture of the ice-cap (Roy, 1937 and 1938). To summarize: The ice-cap occupies the summit of the highland between Hudson Strait and Frobisher Bay. It has characteristics intermediate between those



FIG. 15. Top, coast of Frobisher Bay. Bottom left, a well-formed cirque; right, portion of Everett Range.



FIG. 16. Top, Minturn Bay, Frobisher Bay; bottom, a glacial lake behind Griffin Bay.



FIG. 17. Contrasting landscapes of Labrador (top) and Baffin Land (bottom).

of mountain and continental glaciers, and may well have evolved from earlier mountain glaciers. It is not continuous but is separated by a transverse valley (NE.-SW.) at Jackman's Sound (Lat. $62^{\circ} 22' N.$, Long. $66^{\circ} 10' W.$) into two distinct units—the southeastern and the northwestern ice-caps. The southeastern one is situated at a lower altitude, is smaller, and sends no ice-tongues down to the sea. The absence of ice-tongues may be traced to the wasting of *névé* and ice by the direct rays of the sun, to which the ice-cap is largely exposed. The coastal topography bordering this ice-cap has retained the rounded forms left by the earlier continental ice-sheet.

The northwestern ice-cap is the larger and is situated at a higher altitude. It sends down several ice-tongues to the sea and is fringed by an extremely rugged coastal topography. Occasional calving is taking place, but the resulting icebergs are small. Crevasses are plentiful, indicating that the rock pedestal supporting the ice-cap has numerous surface irregularities. So far as is known, only a single nunatak, located west of Watt's Bay, projects above the ice-cap. The total longitudinal extension of the two units of the ice-cap is about forty miles. Their inland extension is not known but is, perhaps, less.

The ice-cap receives its moisture from ascending air currents after the manner of a mountain glacier. It is, however, of sufficient size to develop local descending and centrifugally directed surface air currents for a part of the year.

NEWELL SOUND; CHANGE IN COASTAL TOPOGRAPHY

Our next stop was at Newell Sound, which is not at all as charted by Hall. Instead of a wide bay it is hardly a mile across at the entrance, and narrows still more farther towards its head. After the first point is passed, it turns southward and a narrow arm leads into a deep round bay which seems to extend southwestward. Altogether, it is about six miles long, judging from the running time of our motor skiff. It was getting dark when we entered this sound and we did not go ashore. The character of the coastal topography now differs from that previously seen. The hills are lower, more rounded, and relatively smoother, showing little dissection since the rounding (Fig. 18). Talus slopes are few or wanting and snowdrifts on the sides of the hills have practically disappeared.

KOOJESSEE INLET AND SYLVIA GRINNELL RIVER; BAFFIN LAND ESKIMOS

Next morning (August 15) we left our anchorage for Koojessee Inlet, taking a circuitous course around Fletcher Island and through narrow channels among numerous islands off Becher Peninsula. The passage is difficult and dangerous, for it is obstructed by numerous reefs and rocky shoals over which cross-seas, at flood, rush in terrifying violence. It may never be attempted except on a clear day and then only if a very sharp lookout from the masthead can be maintained. The current is so strong and eddies are so numerous that a sailing vessel would make scarcely any headway against them.

We were now within sight of the head of the bay. The land at this point assumes an undulating character and rises only to a slight elevation. Islands

are smaller, lower, and more numerous. The tide is thirty-eight feet and covers many of the low islands when at flood stage.

Shortly after we anchored in Koojessee Inlet we went ashore and walked eastward over a narrow divide. Before we were halfway across we saw the Sylvia Grinnell River rushing over rapids into the bay. The river is not large, being hardly 300 feet wide at the rapids, but it is very swift and teems with large sea trout, some weighing as much as eight pounds. We also saw nearby an Eskimo summer camp of sealskin tents. The inhabitants, save for a man too old



FIG. 18. Coastal topography near Newell Sound. The hills are lower, more rounded, and less severely dissected than those of the Everett Range (Fig. 15).

to hunt, consisted of women and children only. The younger men had gone to the interior for caribou. Unlike the Labrador Eskimos, these people live as their forefathers did, closely guarding their ancient customs, habits, and traditions.

NORTHERN LIGHTS

It was nearly midnight when we returned to the ship. The moon was bright for the first time since we entered Frobisher Bay and the sky was illuminated by a gorgeous display of the Northern Lights. The whole horizon was marked by varicolored beams of light rising toward the zenith. Vast flame-curtains opened and closed with inconceivable rapidity. Radiations of reds, greens, and yellows flickered like wind-driven smoke over the heavens. It was a rare spectacle, rare even in this latitude, for not once again did we see so many different types of aurora—arcs, rays, bands, curtains, and others—appear simultaneously. Auroras are believed to be caused by electric discharges of some kind,

the changes either coming from or being induced by the sun. Whatever the cause might be, the auroras invariably brought about a static condition, which seriously interfered with the operation of the ship's radio.

BISHOP'S ISLAND

We hoped to reach the head of the bay by sailing along the northeast coast but scarcely had we left the harbor than the water began to shoal and masses of kelp appeared on the surface. The course was, therefore, changed and we crossed diagonally over to the opposite coast where a good anchorage was found at the north end of Bishop's Island, nine miles from the head of the bay and Jordan



FIG. 19. Tidal flats at the mouth of the Jordan River.

River. The tide here rises to a height of forty-eight feet, the highest we had encountered in the bay. A great expanse of tidal flats (Fig. 19), which at low tides become bare for at least three miles, lies between Bishop's Island and the mouth of the Jordan River. The flats are marked by numerous boulders, reefs, and ledges which serve to set the rising and falling tides in different directions, creating cross-currents that are incredibly erratic and powerful. Perhaps we could have worked our way nearer to the head of the bay in the vicinity of Silliman's Fossil Mount—our next destination—by seeking some channels between islands, but it seemed that the risk involved in the attempt was not warranted by the small advantage that might have been gained.

SILLIMAN'S FOSSIL MOUNT

Next morning (August 17), taking advantage of the rising tide, three of us set out for Silliman's Fossil Mount in our outboard runabout. Our course lay between Preservation Island and several unnamed islands, where Hall experienced a "struggle for dear life." He described the place as "boiling and seething mill-races made by the tide as it rushed along." We met with strong cross-seas

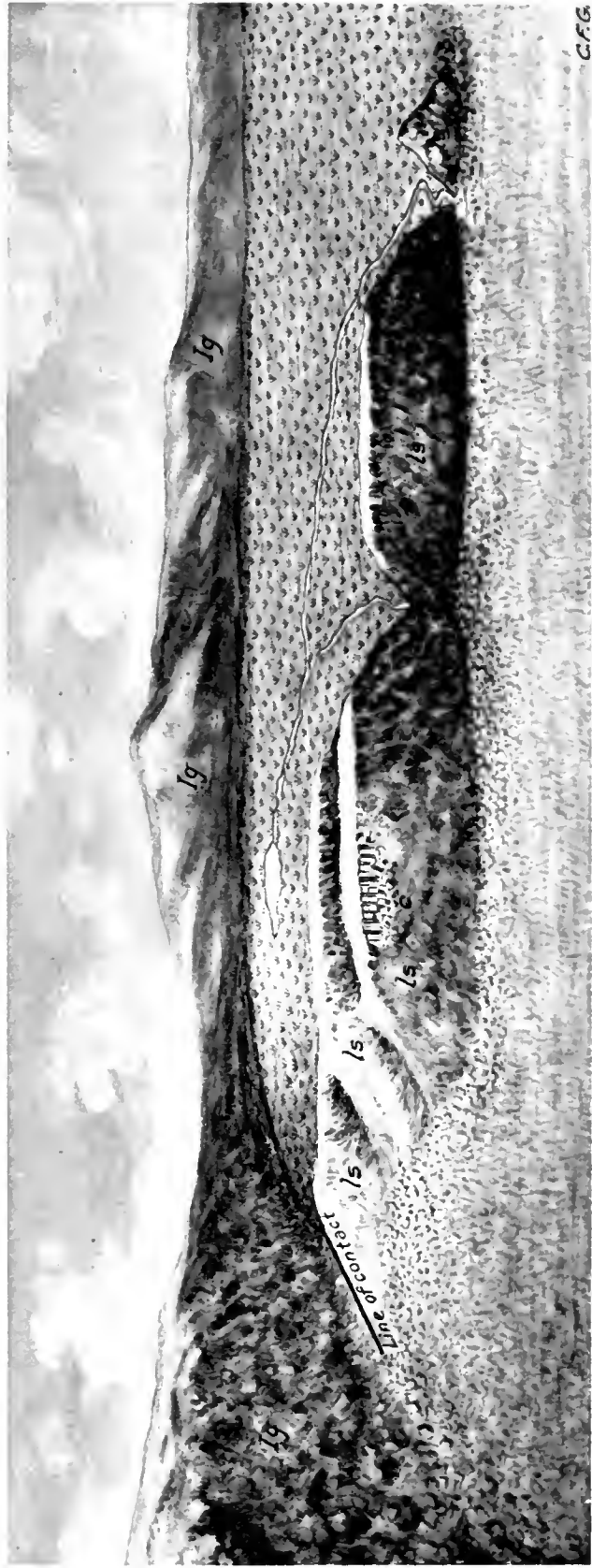
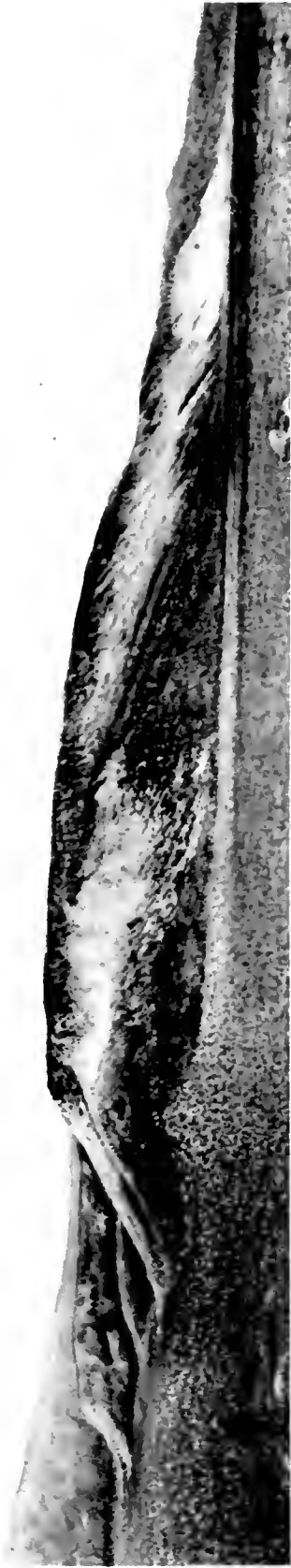


FIG. 20. Silliman's Fossil Mount. Above, panoramic view; below, areal diagrammatic view. Ig = igneous; ls = limestone; c = columnar structure.

and eddies but, on the whole, the journey was uneventful. Unquestionably, it is a treacherous stretch of water but may be considered safe at high tide.

Silliman's Fossil Mount (Fig. 20), named by Hall after Benjamin Silliman, Jr., of New Haven, Connecticut, is, according to our observation, in $63^{\circ} 43' N.$ Lat. and $69^{\circ} 2' W.$ Long. It stands at the west side of the terminus of the bay, about 300 feet from high tide and two and one-half miles south of Jordan River. It is a longitudinal mount of horizontally bedded limestone which lies unconformably on the rocks of the hills of Meta Incognita. It is about three-fourths of a mile long, about 300 feet high, and extends in a general northwest and southeast direction. The mount is not continuous, but is broken in two places. The



FIG. 21. Silliman's Fossil Mount, showing first break (southeast side) and nature of rock disintegration.

first break (southeast side) is a deep V-shaped cut, but the apex of the V has not yet reached the base of the mount nor does it seem that it will do so in the near future. The stream that was responsible for the cut is now well filled up with debris and is practically inactive. The second break (northeast end) has been cut to the level of the base of the mount, and has been made by a smaller stream that winds down the valley between the Fossil Mount and the mountains of Meta Incognita and finally cuts its way through the mount, separating its northeast end from the main body. Hall called this separated portion "a smaller mount of the same character . . . but all in debris." Silliman's Fossil Mount is thus divided into three sections of which the first two are not yet completely separated. To these three sections, a fourth one, hitherto not mentioned by previous visitors,¹ may be added. This section lies behind the first section and extends in a parallel direction to a point as far as the V-shaped cut referred to

¹ Charles F. Hall in 1861 and eight members of a party headed by Russell W. Porter in 1897.

above (Fig. 21). Here it ends abruptly as a steep wall. It is not a distinct unit although a deep trough partially separates it from the front ridge.

The top of Silliman's Fossil Mount, with the exception of the third section (the lesser mount), is flat, table-topped, and covered with glacial erratics and reindeer moss. The lesser mount is bare and has disintegrated to such an extent that it is hardly more than a talus heap. Disintegration of the wall of the mount proper has also been extensive (Fig. 21). The debris, which dips at about 45°, has reached to within fifteen feet of the summit. Portions of the mount that are still intact show horizontal bedding but they too are rapidly crumbling and in some places breaking off in irregular columns (Roy, 1929). The best development of columns is in the uppermost beds at the southeast end of the mount (Fig. 20, c). The columns vary in width and in the number of faces, and are approximately perpendicular to the bedding plane, although some have an inclination of several degrees to it. So far as observed, there were no evidences to indicate that the columns were developed either from concretionary action or from mud cracks. They are apparently the result of a joint system developed from tensional forces acting during the uplift of the area. Joints producing cubical blocks in stratified rocks have two directions, vertical and at right angles. In this case there is an additional diagonal direction which does not lie in the line of intersecting points of the vertical and right-angled joint planes. In such a joint system there would be a series of columns having from three to six faces. Ordinarily, the three-sided columns, being thinner and more angular, would disintegrate first, separating the other columns and increasing the columnar effect of the strata.

Lithologically the limestone beds of Silliman's Fossil Mount vary slightly. At least three variations have been observed but due to the extreme disintegration of the beds it has not been possible to determine whether they intergrade with one another or alternate. For the same reason it is impossible to collect

PHYSICAL PROPERTIES AND CHEMICAL COMPOSITION¹ OF LIMESTONE BEDS OF SILLIMAN'S FOSSIL MOUNT

Nature of bed	Color	Texture	Hardness	Sand and clay	CaCo ₃	MgCo ₃	{ Fe ₂ O ₃ Al ₂ O ₃
Bed A	Buff	Very fine	Hard	1.7	89.45	7.12	1.68
Bed B	Light bluish gray	Shaly	Medium	19.7	73.50	6.91	1.98
Bed C	Bluish gray with dark organic matter and frequently with pyrite	Crystal-line	Very hard	9.8	85.25	6.06	3.07

¹ Analyses by Henry Herperts, formerly Assistant Curator of Geology.

fossils in stratigraphic sequence from these beds. With the exception of a few specimens of *Maclurina* and *Maclurites* (pp. 115–121) and a specimen of *Westenoceras* (pp. 141–143) which were found *in situ* at the top of the mount, all others described in this paper were collected from the talus slopes.

The three variations of the limestone beds at Silliman's Fossil Mount are here called Bed A, Bed B, and Bed C. Their physical characteristics and chemical compositions are shown in the table on page 43.

It has already been stated that the Fossil Mount lies unconformably upon the pre-Cambrian rocks of the Meta Incognita. The line of contact may be seen

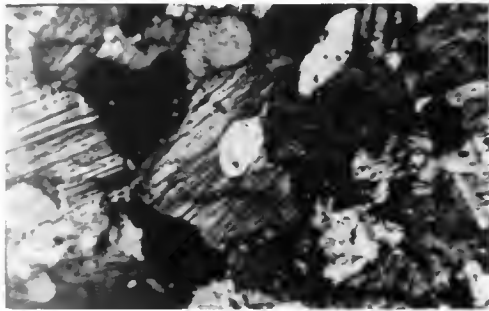


FIG. 22. Thin section of granite underlying Silliman's Fossil Mount.

at the southwest end of the mount (Fig. 20). The rock upon which the limestone rests is a pink granite and not a mica schist, as was previously reported by Stevens (1863, p. 294). The granite (Fig. 22) consists essentially of microcline (55 per cent), quartz (30 per cent), and albite (5 per cent). Chlorite, garnet, magnetite, and zircon are accessory minerals. The chlorite, as evidenced by the freshness of all the other constituent minerals, is not the result of secondary alteration but is deuteritic. The absence of mica

and other ferro-magnesian minerals is a rather unusual feature of this granite.

It may be of interest to reiterate that the mount constitutes the only sedimentary formation observed in place throughout the entire region of the bay, which is nearly 150 miles long and about 50 miles wide at its entrance from Davis Strait. The existence of such an isolated hill of limestone can be interpreted in several ways but the two most plausible explanations seem to be that the mount is either an erosion remnant of the deposits laid down on the irregularly eroded pre-Cambrian surface in the Ordovician and later seas or the result of the erosion of sediments from a graben developed during post-Ordovician-Devonian faulting. The latter interpretation is the more likely since an isolated deposit such as Silliman's Fossil Mount is seldom an erosion remnant.

Previous to our visit to Silliman's Fossil Mount, two other parties had collected fossils there. The first collection, consisting of seven species, was made by Charles F. Hall in 1861; and the second one, consisting of seventy-one species, by a party of eight, headed by Russell W. Porter, in 1897. In addition to these two collections, a third one, believed to have been made by the Eskimos at the mount, was brought to this country by G. Cromer of Boston. The circumstances under which Cromer secured the fossils, consisting of fourteen species, are not known. Information regarding these collections is given on pages 182 to 188. Our collection, representing 68 genera and 116 species, is by far the largest. It was our intention to make a more exhaustive collection and to trace the course of the Jordan River northwards into the unexplored interior but unmistakable

signs of winter appeared suddenly and we had to abandon our plan. On the three succeeding mornings the boat had to be freed from the bay ice and we were afraid we might not be able to get out to the open sea if we delayed longer.

FLETCHER ISLAND AND ESKIMO RUINS; GLACIAL STRIAE

Our return journey began on August 19, three days after reaching Bishop's Island—the farthest point that could be safely reached by a boat drawing ten feet of water. Stopping overnight at Eggelston Bay and for a few hours at Fletcher Island, we sailed across the bay and entered Ward's Inlet where we dropped anchor under the lee of an unnamed island at Edmond Point. At Fletcher Island we found several rock beacons built in the form of crosses of natural slabs. As beacons they are effective, but it is not quite clear why they were erected on this particular island when there are several higher islands close by. Most of the larger islands in Frobisher Bay contain such old Eskimo ruins as cairns, meat caches, tupik rings, stone and sod igloos and various types of artifacts, and they therefore offer a promising ground for those interested in the study of the stone age culture of the north. Glacial striae are not as common on the coast of Frobisher Bay as on that of Labrador, but their occurrence was observed on several islands near the head and middle of the bay. Our halts on these islands, however, were brief, and we were not always prepared to take accurate readings of the directions of the striae. The few measurements that were taken varied but, in the main, the striae followed the axis of the bay, indicating that the ice came from the northeast. It cannot, however, be stated at present whether or not this direction of ice movement was regional or local. The data at hand regarding the direction of striae, being restricted only to certain islands, can scarcely form the basis of a definite conclusion.

WADDELL BAY; FLUVIO-GLACIAL DEPOSITS

Our next anchorage was at the head of Waddell Bay, facing an elevated beach about 120 feet high. Directly behind the beach is an old glacial valley which extends in a general northeast-southwest direction inland for several miles. The valley is a veritable storehouse of fluvio-glacial material and was easily the most desirable place we had visited during our cruise for studying in a practical way different types of glacial forms in their natural environment and in their natural relations to one another.

BREWSTER POINT; DRIFT FOSSILS

Near noon, on August 22, we hove up and left Waddell Bay, heading down the coast between Dudley Field Island and the mainland. The weather was clear over Meta Incognita (opposite coast) and once again as we passed through the channel between Gabriel and McLean Islands and veered to northeast for Brewster Point we saw the ice-cap and three tongues reaching out to sea. A maze of small islands and reefs, most of which become submerged at high tide, lies at the entrance to Brewster Point, but we managed to thread our way between them and dropped anchor in seven fathoms of water in a cove in front of a trad-

ing post. We did not know to whom the post belonged but apparently it was not abandoned. This was the first little house we had seen and perhaps the only one to be found around the bay. Inside the house were a number of white and blue fox skins and in the front yard stood a huge vat filled with walrus tusks. We were tempted to take a pair of tusks but we dared not, perhaps because we could not bring ourselves to violate the time-honored, unwritten law of the North.

Drift fossils in limestone on the hills along the coast are not uncommon, but here and a little northwest of here, in Barrows Peninsula, they seemed to occur in great abundance. These fossils are also of Ordovician age but their occurrence



FIG. 23. Kodlunarn Island, the site of Frobisher's proposed colony.

at an altitude between 1,000 and 2,000 feet or more would seem to indicate that they were brought down by the last continental ice-sheet from the interior rather than from Silliman's Fossil Mount.

KODLUNARN ISLAND; RELICS OF SIR MARTIN FROBISHER

The next morning (August 23) broke calm with thick fog but before long a sudden offshore breeze cleared the fog and we got under way with foresail and jib. Three hours of sailing brought us to Countess of Warwick Sound and Kodlunarn Island—the historic site of Captain Martin Frobisher's proposed colony. We spent the afternoon and the following morning on the island going over the relics which Frobisher had left behind some 350 years ago—almost half a century before the Pilgrim Fathers ventured from their island home to found Plymouth Colony. For a moment the mists of time were parted. The almost legendary beings who faithfully followed the great captain through perilous seas and icy wastes stood before us in the guise of mortal men.

Kodlunarn Island (Fig. 23) is situated at $62^{\circ} 47' 30''$ N. Lat. and $65^{\circ} 10'$ W. Long., about thirty-five miles northwest of the entrance to the bay. The island, as is shown by raised beaches, has risen some fifty feet since Pleistocene time.



FIG. 24. Top, long excavation on the north shore of Kodlunarn Island. It may have been one of Frobisher's mining trenches or it may have served as a dry dock for repairing small vessels. Bottom, another excavation, probably used as a reservoir for fresh water.

Its rocky surface, less than twenty-five acres in area, is without fresh water, and supports no vegetation other than trailing ground willows, lichens, and reindeer mosses. The place is so incredibly desolate and offers so little protection from the rigors of the weather that a more forbidding place for setting up a colony is hard to imagine.

On the north shore of the island, we found a deep canal about 110 feet long, 15 feet wide, and 25 feet deep (Fig. 24). The canal may have been one of Frobisher's mining trenches but it probably served as a dry dock for repairing small vessels. Southeast of the trench we saw a similar but smaller excavation, probably used as a reservoir for fresh water (Fig. 24). The ruins of two furnaces with evidences of old fires and clinkers in them were found between these two excavations. The furnaces were apparently used for assaying the so-called "gold ore." Near the center of the island, the foundation of the experimental house is still recognizable, in spite of the fact that the natives had been picking up whatever took their fancy. Digging around it we found pieces of plaster, brick, porcelain, lime, coal, and flint stones (Fig. 25). The latter were doubtless used for "strike-a-lights." On the east side of the island, facing the sea, we found a sort of crude stone breastwork such as the Eskimos erect for shelter when hunting. It may have been built to serve as a fortification against the natives. Near this stone structure, and most interesting of all, we noticed a small heap of rocks (Fig. 26), some of which fitted the description, "much like sea cole in colour." These rocks are foreign to the island, and, as shown by the growth of mosses and lichens over them, they have not been disturbed since Frobisher's time. The "sea cole colour" of some of the rocks (Fig. 26), their transportation from elsewhere, and their accumulation on the edge of the island whence they could be readily loaded into the ships' holds, suggest that they were the few remainders of the thirteen hundred tons of "gold ore" which Frobisher's men dug up on their last voyage and carried across three thousand miles of storm-tossed seas to swell the rock piles of England.

FROBISHER'S "GOLD ORE"

In reality, the "gold ore" is amphibolite (Roy, 1937, pp. 35-37), consisting essentially of hornblende (80 per cent) and augite and omphacite (10 per cent). Calcite, sodic plagioclase, biotite, magnetite, ilmenite, and titanite, with a sprinkling of quartz, apatite, garnet, and zircon compose the remaining 10 per cent (Fig. 26). The calcite fills the interspaces and was produced by the alteration of the garnet. No pyrite, which has probably precipitated more "gold rushes" than any other mineral, is present. The logical conclusion, therefore, is that it was not the pyrite but the bronzy lustered mica, specks of which the rock contains, which was the real basis upon which Signor Agnello succeeded in perpetrating one of the most amazing hoaxes in the history of maritime adventuring.

LUPTON CHANNEL

Our visit to Kodlunarn Island and further search for the relics were cut short by the unexpected appearance of a herd of walrus in the bay. Our need for meat



FIG. 25. Top, hunting for relics in remains of Frobisher's house: Bottom, relics (chips of bricks, flint, coal, tile, and mortar) of Frobisher's house on Kodlunarn Island.

for the sledge dogs during the coming winter was pressing, so we left the little island with its silent monuments of human courage, industry, and greed, earlier than we wished. Head winds and a choppy sea hindered our progress and we could never have caught up with our anticipated victims had not the stupid animals turned around and made for the boat. As they approached within striking distance we shot and harpooned a large cow and, using dory tackles, managed to hoist her up on the deck. We then steamed down the bay for a few miles and swung northeast through Bear Sound and Lupton Channel, entering the broader waters of Cyrus Field Bay.

Lupton Channel, which lies between Cyrus Field Bay and Frobisher Bay, is frequently used by Eskimos to enter the latter. It is a narrow, crooked passage between cliffs and reefs with a bold island near the middle of the south entrance. Powerful and erratic currents prevail in this channel, making navigation difficult and dangerous. Vessels of any considerable draft should not attempt to pass it at either low or high tide. Wreckage of a whale boat and of a schooner was seen alongside a narrow reef in the channel.

RETURN JOURNEY TO LABRADOR

Our return journey now actually began and as we veered eastward to Davis Strait a gorgeous sunset brightened the horizon. Monumental Island loomed up in crimson and gold. Dark and desolate Lok's Land faded into the night. Sea watches were on; a following breeze filled the canvas; we turned south, reaching our winter quarters at Anatalak Bay, Labrador, three days later, on August 27.

Labrador seemed warm in comparison to our sojourn in Frobisher Bay, but soon the whizzing hordes of insects yielded place to snow and sleet, and, before we had time to realize it, winter came with its biting wind and killing cold. The landscape turned to a vast solitude of glimmering whiteness. Snowshoes and dog teams became our means of transportation. Sledging, however, is no adventure. On the contrary, it is hard work—run and walk, ceaseless watching of the weather, never knowing when a blizzard will strike and blind the view ahead and the trail behind. But despite adverse conditions, the lure of the Arctic is irresistible.

It is probably unnecessary to mention that little field work in geology or paleontology can be done in Labrador during the winter. Apart from the fact that most of the land is covered with snow and ice, the rigor of the climate alone makes prolonged exposure in the open difficult, if not impossible. Winter, however, is the most favorable time for making observations on the work of snow and ice.

MOVEMENT OF BOULDERS BY ICE

One of our observations of the work of snow and ice was that of the movement of boulders of great size, some weighing several tons. The process by which the boulders are moved is very simple; indeed it is so simple that one is likely to overlook it, and generally does. Because of the stormy character of the region, much of the snow that falls during the winter is blown away quickly but there is

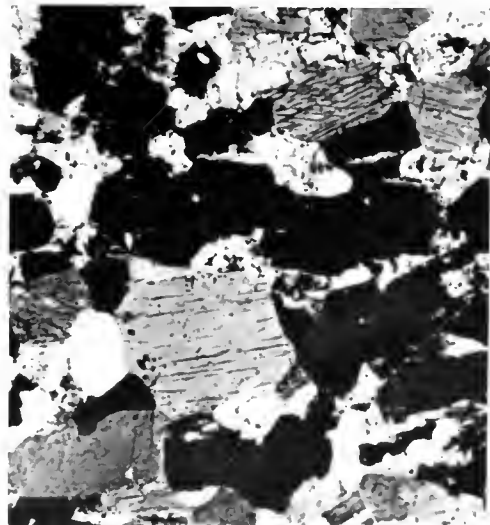


FIG. 26. Top, a pile of lichen-covered rocks, the supposed gold ore. Bottom left, macro-texture of one of the above rocks; right, thin section of the same rock.

always some that drifts in behind boulders, particularly the larger ones. As the snow consolidates and freezes, it expands and the force thus exerted tilts the boulders a little. This creates a space into which sand grains, driven by the wind, and small pebbles are lodged. On warmer days the ice thaws but the pebbles and sand grains serve as a block preventing the boulders from falling back into their original position. The process just described repeats itself many times during a single season, and little by little the boulders are moved farther and farther. To be sure, the process is extremely slow but it is also extremely effective. The boulder shown here (Fig. 28) was observed to move about five inches during 1927-28. Eventually it may reach a slope and roll down, by gravity, into the valley below.

DOMED LAKES

Another interesting phenomenon that we observed was the doming of lake ice. When the water and land freeze solid, the surface of the ice of certain lakes resembles an overturned bowl. The dome may reach an elevation of twenty feet or more above the summer water level. The cause of the doming is not clear. A possible explanation is that the expansive force developed by the freezing of water is unable to overcome the resistance offered by the solidly frozen banks of the lake. It therefore finds release by reacting as a compressional force on the ice, resulting in its doming in a manner somewhat like that in which certain rocks are folded.

ICE MOUNDS

Still another interesting phenomenon observed was that of the formation of ice mounds behind boulders on beaches (Fig. 28). The mounds frequently reach a height of twenty feet. There are many boulders which because of their shape or the position in which they lie on the ground are not carried away by the ice. Such boulders when they are within reach of the tide waters become covered with a coat of ice. The ice increases in thickness with each change of tide until a point is reached when it breaks loose and is lifted up by the tide, creating a void in which a new cap forms and pushes the old one up. Thus, every few days, a new cap is formed and the older ones are forced up until the mass becomes so great that it can no longer maintain its weight and rolls down the sides of the boulder. In this manner huge mounds of ice are built up. Ice mounds are very numerous and they often form a barrier in the entrances to bays.

"DRIFT" SNOW

A constant topic of conversation during the winter in Labrador is that of the "drift." The term "drift," as used by the natives, is not what we generally call snowdrift but is a living, moving mass of powdery snow dust that has been picked up and carried along by the wind. Very often it reaches a height of ten feet or more. No one dares to go out into it, for to do so is almost certain suicide. Objects within arm's length cannot be seen. In it one loses all sense of direction; pathways that may be followed on the darkest night become strange and unfamiliar. When accompanied by strong wind it cuts like a sand blast and facing



FIG. 27. Top, expedition's winter quarters; bottom, a typical Eskimo house.

it is all but impossible. The dust is so powdery that it enters the very smallest opening and packs solidly inside the clothes. The power of its erosion can scarcely be exaggerated. In a single night it polishes the sea ice until the smoothest of new ice seems rough by contrast. It brings out, as no tool of man can do, the grain of the wood on the houses that are exposed to it, and it shears the shoots of small plants that grow in the clefts of mountains and rise a few inches above the rocks down to a level as uniform as the top of the best-kept hedge. Geologically, this so-called "drift" is a most effective agent of destruction. Not only does it eat away the softer minerals, exposing the harder ones to the weather, but it also enters the minutest pores and cracks in rocks where it freezes, loosening their component parts and paving the way for their later disintegration.

"QUOR" WATER

Of all phenomena relating to ice and snow that we had the opportunity to observe, the most interesting was the presence of fresh, flowing water on the beaches and nearby areas at air temperature many degrees below freezing. This water is known locally as "quor" water. What the term means is not known unless it be the degenerated form of the word "queer," but to find flowing water when even the swiftest brooks have frozen to a depth of a foot or more is perplexing.

Early in the summer when we were looking for a suitable site for our winter quarters, one of our prime considerations was to insure a good supply of water at all seasons. With this idea in mind, we always inquired about it in each place that appeared to us otherwise promising. We were told that we could get all the water we should need if we dug but a few inches below the surface of the ice on any of the brooks but that if the winter was very severe and the ice was too thick to break through to reach water, we could always get plenty of "quor" water. At that time we could not quite understand what "quor" water might be, nor do we understand much more about it now, except that it is a source of water that can be obtained with little or no effort. Apparently, it is some form of seepage from considerable depth below the level of the frozen ground, where circulation of water is possible. Yet it is difficult to explain why the water should collect in streams and flow out on the accumulated ice without freezing during emergence from such a depth at temperatures many degrees below the freezing point. It may be that the hydrostatic head is sufficiently high to exert the pressure needed to account for the phenomenon.

Although "quor" water is a great blessing as a source of abundant drinking water, and although it eliminates the laborious process of obtaining water by quarrying and melting ice, it is also a real menace. Because of the constant seepage, the snow is kept so mushy that it is extremely difficult, and often impossible, to walk along the beaches, where the "quor" water seems to be more prevalent than elsewhere. Wet feet, when the temperature is hovering around 30 degrees below zero, are likely to freeze without warning. The situation assumes serious proportions, however, when "quor" water appears near dwelling



FIG. 28. Top, ice mound formed by tide waters; bottom, a huge boulder moved five inches during a single season by the work of ice.

houses. During the winter of 1927-28, "quor" water filled the sawmill at Nain to a depth of many feet and entered a number of houses, forcing the occupants to abandon them. In late spring when the owners returned they found ice as much as three or four feet thick in their living rooms. In the neighboring villages, some houses were completely buried.

The examples of the work of snow and ice briefly stated herein are a few of the many that may be observed during the winter. The purpose of recording them is to stimulate further investigation on the subject by those who may have occasion to spend a winter in Labrador.

DESCRIPTION OF FOSSILS

INCERTAE SEDIS

Family *Receptaculitidae* Roemer

Genus *Receptaculites* DeFrance

The genus *Receptaculites* was established in 1827 by DeFrance (Dict. Sci. Nat., 45, p. 5, pl. 68), who compared the rhomboidal outer plates of the organism to the arrangement of the scales of a pine cone, although in his final analysis he believed it to be a coelenterate of some kind. Since DeFrance's time various investigators have studied the morphology of this genus and attempted to determine its systematic position but with widely varying results. Among those (Goldfuss, Eichwald, Salter, Billings, Dames, Gümbel, Roemer, Rauff, and Hinde) whose names stand out prominently in this connection, Billings and Rauff seem to have seen more clearly, particularly as to the nature of the complete forms of the organism.¹ The Baffin Land *Receptaculites* described and figured in the following pages add little to the solution of the uncertainties surrounding the taxonomy of the group. It would, therefore, be hardly profitable to give here a résumé of the divergent opinions of all the authors just mentioned. Two specimens (F.M. Nos. P28822, P28823), however, do help to clarify certain fundamental morphological features of the genus and may be briefly discussed here.

Billings believed that *Receptaculites* possessed a variable form with a covered summit and a central cavity. He (1865, p. 379, text fig. 353) observed: "The genus may be described as consisting of organisms which, when full grown and perfect, are of a discoid, cylindrical, ovate, or globular shape, hollow within, and usually, if not always, with an aperture in the upper side." He (p. 379) further added: "The flat watch-shaped specimens which are usually figured as constituting the whole of the body, are probably only the basal portion of the body-wall of the discoid species." Hinde (1884, p. 821) disagreed with Billings' interpretation and asserted: "There seems no evidence in favor of the supposition of Mr. Billings that the complete specimens of this genus possessed dome-shaped or conical summits similar to those of *Ischadites*, for though platter and cup-shaped examples are abundant in certain strata, and apparently perfect as regards their outer form, yet in no single instance has an upper portion been discovered in connection with them; and if we take into consideration the numerous instances in which the smaller and more delicate forms of *Ischadites* still retain their complete form and conical summits, the conclusion appears justifiable, as Gümbel has already remarked, that the specimens of *Receptaculites* were originally of the form in which they are now found as fossils. No specimen

¹ It might be desirable to investigate the possibilities of relationship between the Receptaculitidae and the Archaeocyathinae. Superficially there are certain similarities, the most apparent of which is that the skeletons of both are double-walled. Furthermore, the intervalum (the space between the walls) in both is crossed by rod-like structures. For detailed discussions on the Archaeocyathinae, see T. Griffith Taylor, Mem. Roy. Soc. South Australia, 2, pt. 2, 1910; and P. E. Raymond, Bull. Mus. Comp. Zool., 9, No. 6, pp. 172-177, 1931.

has yet been found to correspond with the diagrammatic representation which Mr. Billings [1865, p. 378, text fig. 353] has given of a supposed complete example of the genus." Rauff (1892, pp. 8, 9) maintained that *Receptaculites* possessed

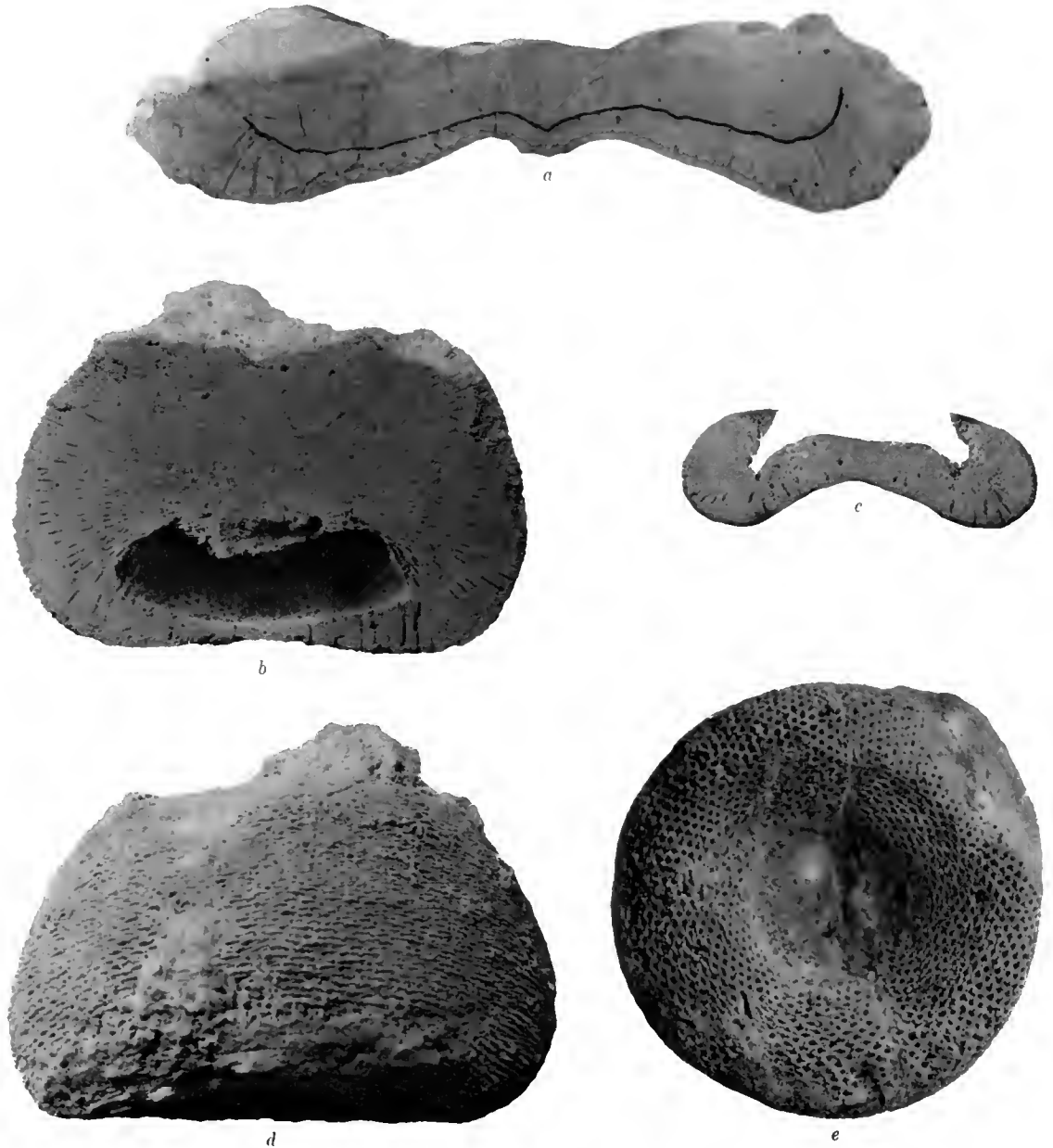


FIG. 29. *a, c*, Vertical sections of discoide specimens of *Receptaculites* and *Ischadites* respectively, showing nature of curvature of peripheral walls. *b*, Vertical section of a nearly complete specimen of *Ischadites iowensis*, showing the bell-shaped central cavity. *d*, A nearly complete specimen of *Ischadites iowensis* in which the conical upper portion is preserved. *e*, Discoide form of *Ischadites iowensis*. All natural size.

a spherical or pear-shaped body with a central hollow and a completely closed summit. He was also of the opinion that the disk-shaped specimens of *Receptaculites* are only fragments of originally closed forms. Rauff's observations,

thus, are in accord with those of Billings except that the latter thought that the summits were not completely closed but that they had usually, if not always, small apical apertures.

The two Field Museum specimens, though not complete, substantiate Billings' and Rauff's observations, especially as to the presence of an upper portion. The larger specimen shows clearly that it was subconical (fig. 32, *a*) with a subcircular base (fig. 32, *c*). Its vertical section (fig. 32, *b*), like that of Billings' diagrammatic representation (1865, p. 378, text fig. 353), reveals a large, rapidly converging central cavity. The smaller one, with the extremity preserved, is pear-shaped with a bent neck (fig. 33, *a*). It also shows a rapidly converging cavity. Both of these specimens resemble *Ischadites* in external form but possess an inner integument, which is a diagnostic character of *Receptaculites*.

There are good reasons to believe that Billings and Rauff were correct in suggesting that disk-shaped specimens of *Receptaculites* are only the basal portions of once complete individuals, but positive data are not available to prove whether the summits were closed or open. This conclusion is based not only on specimens¹ which have actually retained the upper portions, but also on the manner in which the preserved portions of the peripheral walls of all discoid (hence incomplete) specimens are curved (fig. 29, *a*). This curvature is such that it is difficult to conceive of any possible manner by which the peripheral walls may have terminated other than by continuing upwards and forming some sort of upper covering. Further strong analogical evidence may be drawn in support of this view from specimens of *Ischadites iowensis* (Owen). Nearly all specimens of this species are preserved in the discoid form (fig. 29, *e*), as are those of *Receptaculites*, but some nearly complete forms (fig. 29, *d*) have been found with conical upper portions and bell-shaped central cavities (fig. 29, *b*), showing clearly that the discoid specimens of *I. iowensis* are only incomplete basal portions. Furthermore, the peripheral curvatures of discoid forms of *I. iowensis* (fig. 29, *c*) which are known to have possessed upper portions are almost identical with those of discoid specimens of *Receptaculites* (fig. 29, *a*), suggesting that what is true of the former was in all probability also true of the latter.

NOTES ON THE TERMINOLOGY OF RECEPTACULITES

So many different terms have been used by different writers to describe the same structural components of *Receptaculites* that it is impossible to become familiar with them without perusing voluminous literature. Therefore, for the convenience of those interested in this genus, there is appended a table giving terms and synonyms used by various authors, with a brief explanation of each. In describing the three following species of *Receptaculites*, the self-explanatory and hence simpler terms used by Hinde have been employed. It is, however, not to be concluded that the terms used by other authors are inappropriate.

¹ The specimens were collected by Dr. E. O. Ulrich and are now in the United States National Museum.

TERMINOLOGY USED BY VARIOUS AUTHORS TO DESCRIBE STRUCTURAL PARTS OF RECEPTACULITES

Brief explanation of different terms is given in the last column

E. Billings *	W. Dames	C. W. Gümbel	G. J. Hinde	H. Rauff	Explanation
Ectohorin			Outer layer	Aussenfläche	Outer surface (fig. 30, a)
			Spicules	Merome	Component structural parts of the body-wall
Rhomboidal or hexagonal plates of the ectohorin	Rhomboi-dische Tafeln	Rhombische Plättchen	Head or summit plate	Täfelchen	Plates of the outer surface (fig. 30, b)
Stolons	Kanäle	Epistyle Stutzarme	Horizontal rays	Tangential- arme	Four horizontally extended arms or rays immediately beneath the head-plate (fig. 30, c, d, e, f)
Radial stolon		Radial centripetaler Ast	Proximal angle and ray	Distaler Arm	That horizontal ray which points inwards toward the nucleus (fig. 30, c)
Radial stolon		Radial centrifugaler Ast	Distal angle and ray	Proximaler Arm	That horizontal ray which points towards the periphery of flattened specimens or towards the summit of conical specimens (fig. 30, d)
Cyclical stolons		Concentri-sche Aestchen	Lateral angles and rays	Lateral- arme	The two horizontal rays which project at right angles to the direction of the proximal and distal ones (fig. 30, e, f)
Cylindrical tube or hollow spicule	Cylindri-sche Röhre	Säulchen	Vertical ray	Säulchen or Columell	Subcylindrical arm or ray extending at right angles to the horizontal rays towards the interior, reaching to the inner layer (fig. 30, g)
Endohorin		Innere Hülle	Inner layer	Innenfläche	Inner surface (fig. 30, h)

* With the exception of the term "cells" for "cylindrical tubes" of Billings or "vertical rays" of Hinde, American authors have generally followed the terminology of Billings.

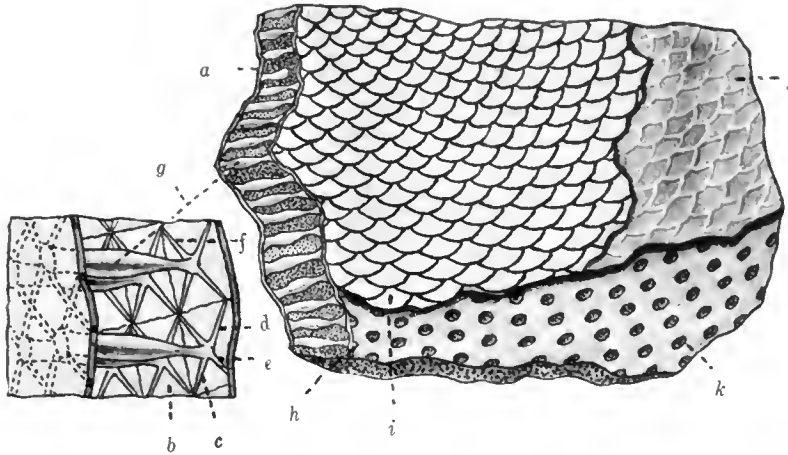


FIG. 30. Diagrammatic representation of component parts of body-wall of *Receptaculites* (modified after Salter and Billings). *a*, Outer layer. *b*, Head plate. *c*, Proximal angle and ray. *d*, Distal angle and ray. *e*, *f*, Lateral angle and rays. *g*, Vertical ray. *h*, Inner layer. *i*, *j*, Weathered surface (inner), showing plates. *k*, Free ends of vertical rays.

Receptaculites sp.

Description.—Subcircular in outline with incurved margins. Maximum diameter 117.5 mm. ($4\frac{5}{8}$ in.). Approximately two-thirds of the basal outer surface depressed, in or near the center of which is situated the so-called nucleus, which is small and conical. Summit of nucleus well below level of adjacent higher surface. Head-plates rhomboidal but not easily recognizable, radiating outwards to the peripheral margins in curved lines from the nucleus. The character of the vertical rays cannot be clearly seen; they vary considerably in length and width, being short and wide at and near the nucleus, becoming longer and narrower as they approach the incurved margins. The total thickness between the inner and outer walls is 6 mm. at the nucleus, 12 mm. at the margin. Neither the canal system nor the horizontal rays are distinguishable, both having merged into a wavy layer of calcite above (inner layer) and below (outer layer) respectively.

Remarks.—This form may be related to or even be conspecific with the one described by Etheridge as "*Receptaculites arcticus*" (probably not a valid species). It is, however, not definitely identified here for two reasons: (1) The outlines of the vertical rays are not clear; and (2) the definite specific characters that distinguish *R. arcticus* from *R. occidentalis* Salter and *R. oweni* Hall have not been satisfactorily recognized. Size cannot be regarded as a specific character nor can the forms of the head-plates, for these vary considerably in the same specimen. The horizontal rays as well as the canal system are rarely seen and, even if present, they help but little in specific differentiation. The only other important structural component of the spicule is the vertical ray, apparently with two distinct types: one with constriction at one end, next to the horizontal rays; the other spindle-shaped, constricted at both ends. Both types, however, may occur in the same specimen although one or the other is usually predominant

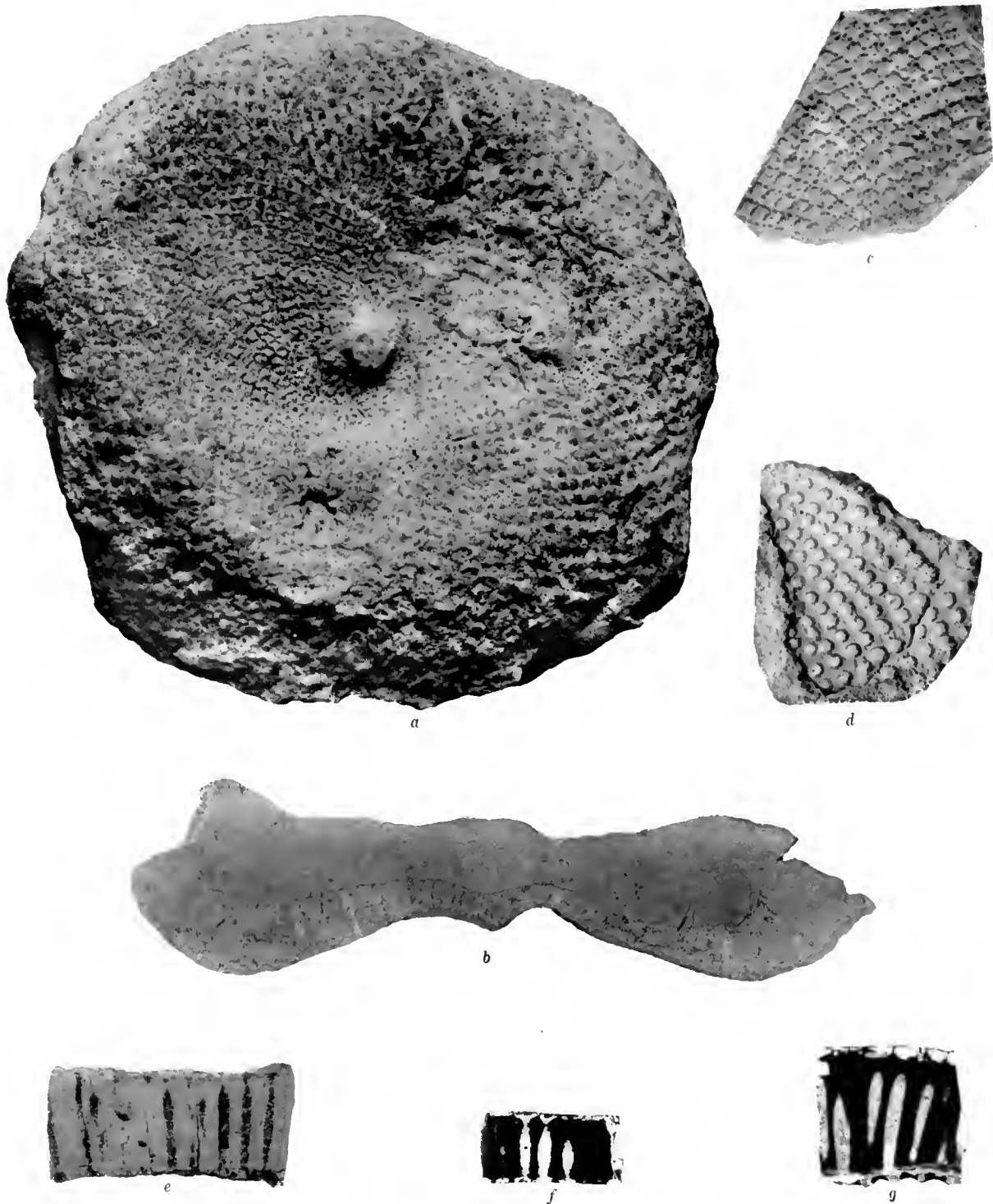


FIG. 31. *Receptaculites* sp. F.M. No. P28821. *a*, Basal outer portion of an individual. *b*, Vertical section of the same through the nucleus. *c*, *d*, Weathered fragments of two different individuals, showing plates of outer surface and free ends (inner side) of vertical rays, respectively. *e*, *f*, *g*, Fragments of body-walls from different parts of one or more individuals, showing variations of forms of vertical rays. All natural size.

—a feature which may be regarded as a good specific character providing that the specimen is fairly complete and a good portion of it can be examined. The width of the vertical rays, however, is no positive criterion for specific separation. Fig. 31, *b*, clearly demonstrates how the width varies, being much wider adjacent to the nucleus than at the margins. The length, of course, in all cases corresponds to the thickness between the walls and has no value in this connection. The spacing of the vertical rays also may not be regarded as a good specific character, for it too varies in different portions. Obviously, then, it is almost impossible to make correct identifications of fragmentary specimens of *Receptaculites*. Inasmuch as most specimens are found in this condition an overburdened literature has unfortunately accumulated. The illustrations (fig. 31, *e, f, g*), showing fragments of different individuals with diverse shape and size of the vertical rays, even in the same specimen, give an adequate idea of the difficulty in which the investigator finds himself when attempting to make positive identifications.

Winchell and Schuchert (1895, p. 59) distinguished *R. oweni* from *R. occidentalis* by "the greater size attained by *R. oweni*, and the plates of the inner surface having twelve canals instead of four, as in *R. occidentalis*, a central knob on each head-plate of the spicules on the outer surface of the former" I have examined a large number of specimens of *R. oweni* but in no instance have I been able to see the "twelve canals" on the inner plates. In fact, in no specimen that I have examined are the inner plates sufficiently well preserved to examine the canal system satisfactorily. It would seem taxonomically unlikely, however, for two closely related species to be distinguished by so striking a character as the presence of twelve canals in one as against four in the other. The "central knobs" on the head-plates are probably not structural features at all but are results of a peculiar condition of preservation. At least they are not observable on the great majority of specimens. The important differences between *R. oweni* and *R. occidentalis* seem not to be those previously emphasized but rather to rest in the shape of the vertical rays. In the former, the vertical rays are predominantly spindle-shaped, cylindrical in the middle and contracted both above and below, whereas in the latter they are contracted only below, next to the horizontal rays. This difference, however, cannot always be relied upon, especially when it is a question of identifying fragmentary material, for, as discussed above, both types of vertical rays may appear in the same specimen. According to the original description of Etheridge (1878, p. 576) *R. arcticus* differs from *R. occidentalis* in having "tubuli [vertical rays] more glass- or spindle-shaped, much more so than in *R. occidentalis*, where they are nearly columnar; the upper ends or terminations of the tubes [vertical rays] do not appear to expand so much as in *R. occidentalis*" From Etheridge's description it would seem that the vertical rays of both *R. arcticus* and *R. oweni* are similar. The work of Hinde, however, makes this conclusion untenable. In his description of Etheridge's types of *R. arcticus* in the British Museum he (1884, p. 845) stated: "The vertical rays, like those of *R. occidentalis*, are contracted immediately beneath the horizontal rays and then expand again and continue of an even thickness to their junction with the inner or upper plate." Unfortunately,

neither Etheridge nor Hinde supplemented his description with illustrations. It is, therefore, impossible to ascertain from the literature alone which of these two writers is correct. If the vertical rays of *R. arcticus* are similar to those of *R. occidentalis* then the former is more closely related to the latter than to *R. oweni*; if not, then the reverse is true. In summing up: *R. occidentalis* and *R. oweni* are two distinct species which can be recognized by their vertical rays when well-preserved specimens are available, whereas *R. arcticus* is probably synonymous either with *R. occidentalis* or with *R. oweni*, depending on whether Etheridge or Hinde was correct. If *R. arcticus* is a distinct species it will have to be based on characters other than those mentioned in the literature.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Receptaculites(?) fieldi Roy, sp. nov.

Description.—Conical as preserved; basal outline subcircular. Central cavity in vertical section triangular, gradually converging. Average space

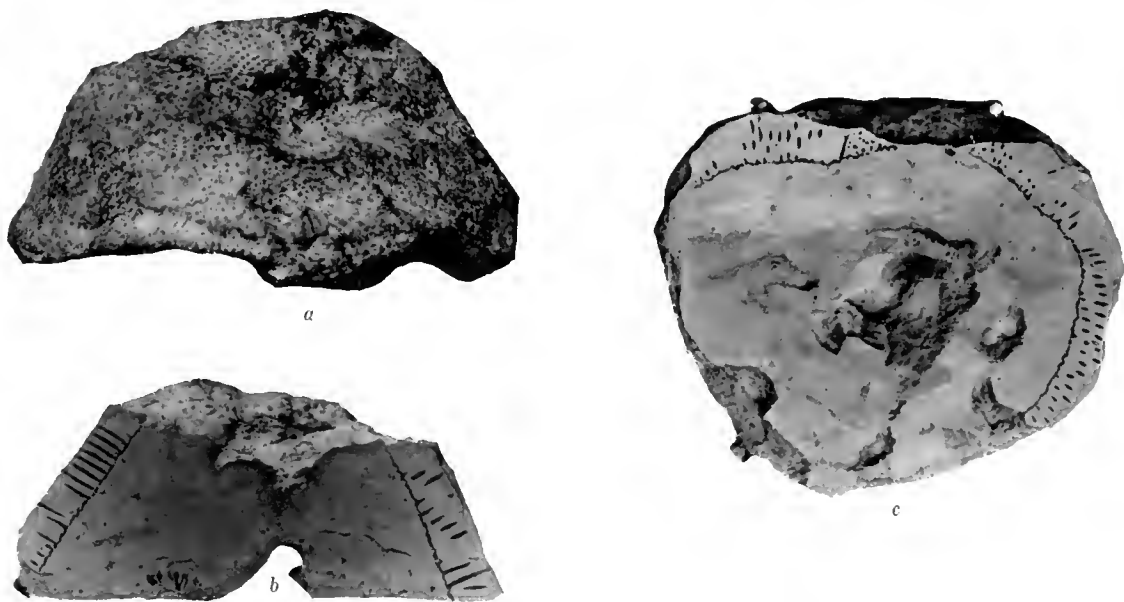


FIG. 32. *Receptaculites fieldi* Roy, sp. nov. F.M. No. P28822. a, Upper portion. b, Vertical section. c, Basal surface (polished). All natural size.

between outer and inner layers about 6 mm. Head-plates not clearly seen. Vertical rays slender, narrow but not constricted next to the horizontal rays, expanding gradually towards the inner layer.

Diagnosis.—The only described species of a closely allied genus which it resembles most in external form is *Ischadites koenigii* Murchison (R. I. Murchison, *Siluria*, 1854, pl. 12, fig. 6; *Receptaculites jonesi* Billings, 1865, p. 385, fig. 363; also Hinde, 1884, pl. 36, fig. 1, a) but the present species has a distinct inner

layer and the central cavity is not bell-shaped but gradually converging. The body-wall of the present species also is of more even thickness—a feature which is not usual among the known species of *Receptaculites*.

Remarks.—The basal outline, which is not quite circular, indicates that the completed form of this species was not exactly conical but was slightly bent on the relatively straight side of the basal circumference.

The specific name is in honor of Mr. Stanley Field, President of Field Museum of Natural History.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28822.

Receptaculites sp.

Remarks.—Only a part of the upper portion of this form is in the collection. Its original entire form, as can be judged from the preserved portion, was pear-

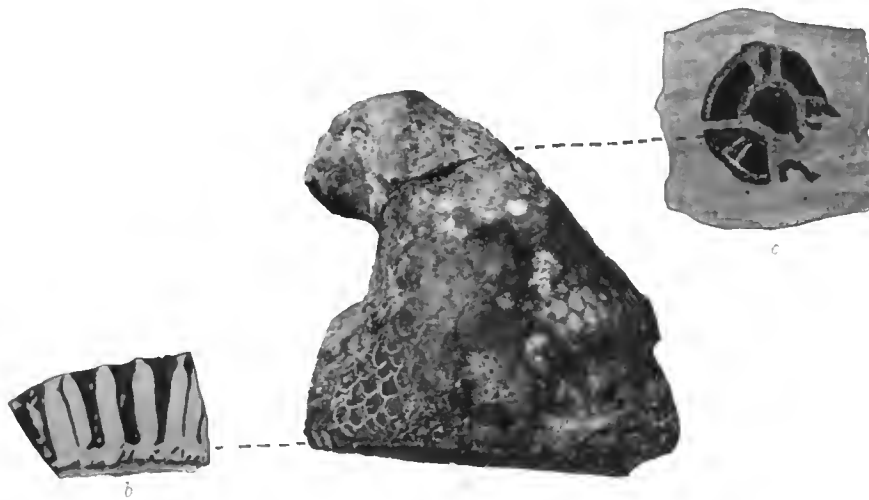


FIG. 33. *Receptaculites* sp. F.M. No. P28823. *a*, Upper portion. *b*, Vertical rays. *c*, Cross section showing inner layer and central cavity. All approximately $\times 2$.

shaped with a bent neck, somewhat like a crookneck summer squash. It closely resembles the published figures of *Ischadites murchisoni* Eichwald in general outline but structurally it is a *Receptaculites*, since it has a distinct inner layer (fig. 33, *c*). The head-plates are more quadrangular than rhomboidal and have more or less curved sides (fig. 33, *a*). The vertical rays are cylindrical, constricted next to the horizontal rays (fig. 33, *b*) in the manner of those of *R. occidentalis* Salter. The central cavity converges rather rapidly but, since the tip of the summit is not preserved, it is not known if the cavity extended throughout to end in an apertural opening.

This specimen is too imperfect to serve as a type but it is unlike any described species of *Receptaculites* and doubtless represents a new species.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Phylum COELENTERATA

Class Anthozoa

Subclass Tetracoralla

Family Zaphrentidae Edwards and Haime

Streptelasma spp. I, II, and III

Remarks.—There are at least three different species of *Streptelasma* in the collection. Unfortunately, however, none of the specimens representing these species is entire, nor are there more than two specimens of each kind. It has thus been difficult or impossible to make specific identifications.



FIG. 34. *a, b, c, Streptelasma* sp. I. F.M. No. P28824. *a, b*, Lateral views. *c*, Transverse section of a different individual. *d, Streptelasma* sp. II. F.M. No. P28825. *e, f, Streptelasma* sp. III. F.M. No. P28826. Lateral views of two different individuals. All natural size.

Streptelasma sp. I is probably allied to *S. breve* Winchell and Schuchert. It is a small, rapidly expanding form, but because the specimens representing it are not entire, exact dimensions cannot be given. The calyx is slightly ovate in cross section, the longer diameter being 16 mm. and the shorter 14 mm. Septa long and short with about forty of each kind. Surface marked by faint longitudinal ribs and crossed by closely set concentric lines of growth.

Streptelasma sp. II has a short, conical form with a median keel and two lateral ones. The calyx is circular, having a diameter of 25 mm. at a distance of about 28 mm. above its apex. This form may be related to *S. robustum* var. *amplum* Troedsson, from the Cape Calhoun beds, Cape Calhoun, Greenland.

Streptelasma sp. III is much like *S. corniculum* Hall. The specimen is about 40 mm. long, conical, and expanding gradually from a pointed base. Calyx circular, having a diameter of about 22 mm. at a distance of about 30 mm. above its apex. Septa alternately long and short, about 100 in all. Surface marked by rather strong longitudinal ribs and crossed by both conspicuous and inconspicuous wrinkled concentric lines of growth.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes, Ralph Robinson, and Sharat K. Roy.

Family Cyathophyllidae Edwards and Haime

Genus Favistella Hall

Favistella sp.

Only a fragment of a corallum representing this form was collected. The specimen, however, was mislaid and cannot now be found. At present it is represented by two cross sections and one longitudinal (rather inclined) section.



FIG. 35. *Favistella* sp. F.M. No. P28827. *a*, Cross section; $\times 4$. *b*, Longitudinal (considerably inclined) section; $\times 4\frac{1}{3}$.

Description.—Corallum composed of polygonal corallites in contact with one another. Diameter of corallites varies from 3 to 6 mm. Septa about twenty-six in number, alternatingly long and short, the former strong and extending almost

to the center, the latter mere vertical ridges along the corallite walls. Tabulae horizontal or slightly concave.

Remarks.—Inasmuch as the specimen representing this form is lost, it has been deemed desirable not to identify it with any described species from thin sections alone. The sections, however, closely resemble those of *Columnaria* (*Favistella*) *alveolata* Goldfuss.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Subclass Alcyonaria

Family Heliolitidae Lindström

Subfamily Plasmoporinae Kiaer

Genus *Plasmopora* Edwards and Haime

Plasmopora lambei Schuchert

*Plasmopora lambei*¹ Schuchert, Proc. U. S. Nat. Mus., **22**, p. 154, 1900; Hume, Mem. Geol. Surv. Canada, **145**, pl. 5, fig. 1a, b, 1925; Troedsson, Medd. om Grønland, **72**, p. 118, 1928 (in part; probably only pl. 32, fig. 1, specimen No. 691); Teichert, Rept. Fifth Thule Exped., 1921–24, Gyldendalske Boghandel, Nord. Forlag, **1**, pp. 53–54, 1937.

Original description (Schuchert, 1900, p. 154).—“This species begins growth on some small foreign object, and expands to a diameter exceeding 12 cm. by 7 cm. in height. Beyond the place of attachment the lower surface is irregularly concave and covered by a thin epitheca. The upper surface is in form depressed hemispheric to conical. Corallites from 1 to 1.75 mm. in diameter, commonly about 1.25 mm., circular, and separated from one another from 0.5 to 1.25 mm. Septa not prominent, and where the original surface is well preserved not easily distinguishable from the radial striations, or granular surface, of the tubular area. Corallites with very closely adjoining tabulae, which are generally decidedly vesicular, but in places they are flat. In longitudinal sections there are from two to five tubules between neighboring corallites; the tabulae are convex, generally giving the inter-corallite space a decided vesicular structure.

“The general vesicular condition of the tabulae in both the tubules and corallites distinguishes *P. lambei*.”

Remarks.—The above description agrees well with the external and internal features of the several Field Museum specimens. It seems desirable, however, to add here a few more characters not mentioned in the original diagnosis.

The under surface of the corallum of this species is commonly covered by a concentrically wrinkled epitheca. The corallites are circular, with slightly raised margins. The radial striations or costae are twenty in number. They are not in direct continuation with the septa, and could not very well be, if the

¹ Inasmuch as the species *lambei* was proposed by Schuchert in honor of L. M. Lambe, the correct designation, as has been already pointed out by Teichert (1937, p. 54) should preferably be *lambei*.

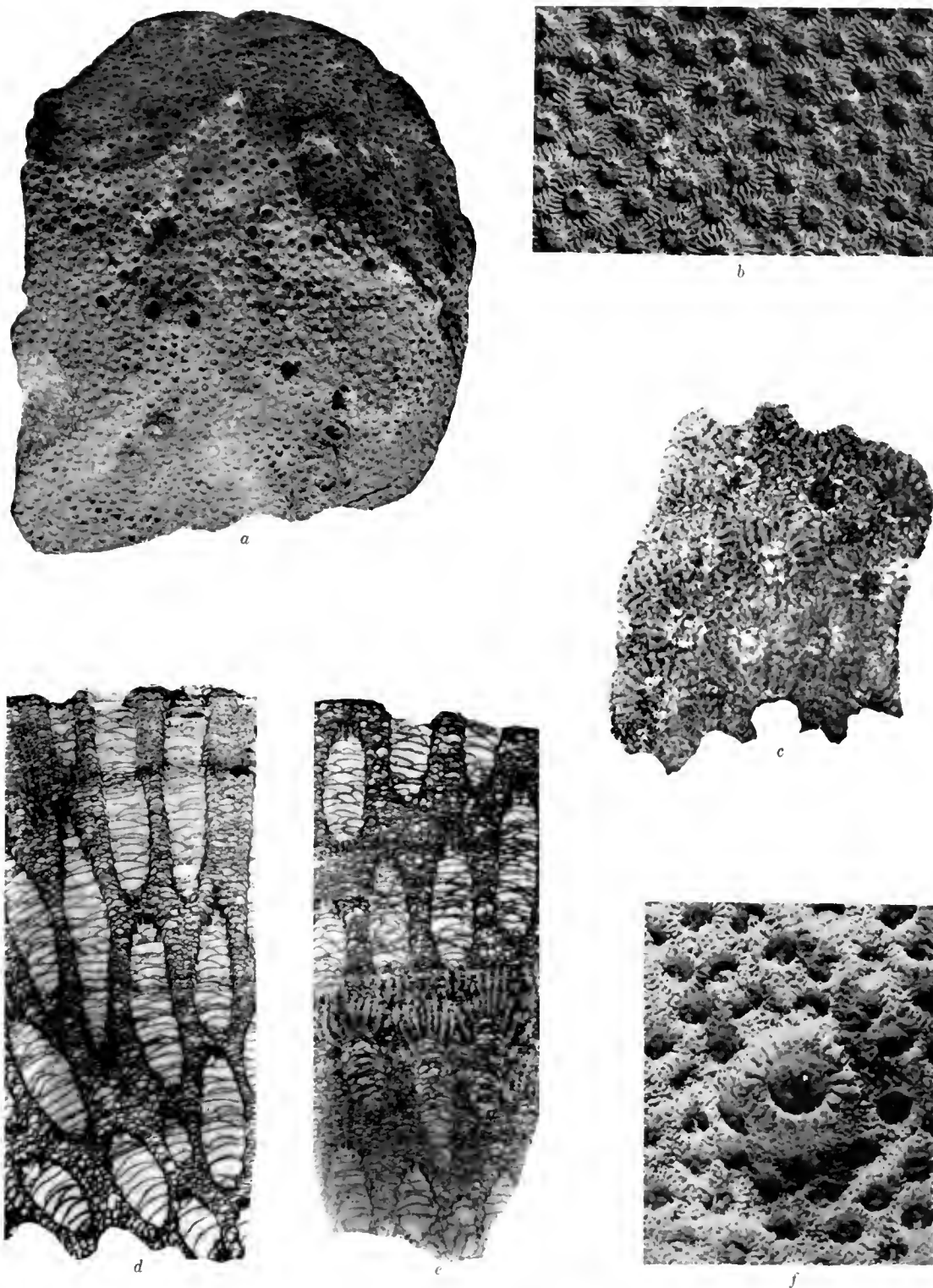


FIG. 36. *Plasmopora lambei* Schuchert. F.M. No. P28828. *a*, Upper surface of a corallum; natural size. *b*, Enlarged corallites. *c*, Transverse section; $\times 3\frac{3}{4}$. *d*, *e*, Longitudinal sections; $\times 3\frac{3}{4}$ and $4\frac{1}{2}$, respectively. *f*, Injured corallite, enlarged. The holotype of this species (U.S.N.M. No. 28140) is in the United States National Museum.

number of septa in each corallite is only twelve, as previously believed. It has, however, not been possible to determine the number of the septa, which presumably are represented by only a slight, wedge-shaped thickening of the walls of the corallites. The costae apparently project over the corallite openings, thus obscuring the outline of the septa and impeding clear observation.

An important distinguishing feature of this species is the absence of polygonal divisions in the inter-corallite fields. This absence is the result of the union of the costae at an angle with the corresponding ones of the adjacent corallites without bifurcating or joining with additional transverse ridges between juxtaposed corallites. Both complete and incomplete tabulae occur. They are straight, convex, or irregularly curved. The tabulae of the tubules are similar but they are much more varied in shape, some of them being mere vertical zigzag lines.

As may be seen from the longitudinal sections (fig. 36, *d, e*), the growth of the corallites apparently has been arrested periodically, during which times there seems to have been an excessive gemmation of the tubules. Some specimens of this species display on their surface a few conspicuously larger and more elevated corallites (fig. 36, *f*) having a greater number of costae. The exact nature of these corallites is not known, but they may have resulted from injury and subsequent repair of the normal corallites.

Collectors.—John Jaynes, Ralph Robinson, and Sharat K. Roy.

***Plasmopora pattersoni* Roy, sp. nov.**

Plasmopora lambei Troedsson, Medd. om Grønland, 72, pp. 118–120, 1928 (in part; probably pl. 31, fig. 1a, b, pl. 32, fig. 2, pl. 33, fig. 1a, b); Teichert, Rept. Fifth Thule Exped., 1921–24, Gyldendalske Boghandel, Nord. Forlag, 1, pp. 53–54, pl. 4, fig. 13, pl. 5, figs. 1, 2, 1937.

Diagnosis.—This species is closely allied to the preceding species, *Plasmopora lambei* Schuchert, but the differences between the two seem definite and sufficient to warrant their separation. These differences are:

<i>P. lambei</i> Schuchert	<i>P. pattersoni</i> Roy, sp. nov.
Corallum small; depressed hemispherical	Corallum large; usually conical
Corallites average 1.25 mm. in diameter	Corallites average 2.25 mm. in diameter
Costae twenty in number	Costae twenty-four in number
Inter-corallite fields irregular	Inter-corallite fields polygonal
Tabulae of corallites about twenty in 6 mm.	Tabulae of corallites about thirty in 6 mm.

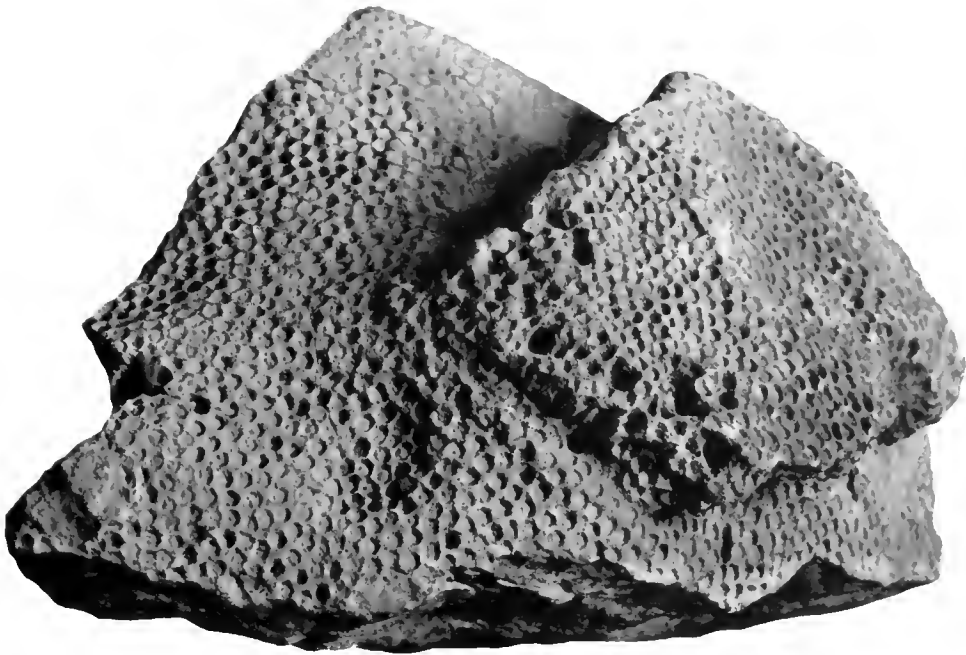
Remarks.—The features seen in figures of “*P. lambei*” given by Troedsson (1928, pl. 31, fig. 1a, b, pl. 32, fig. 2, pl. 33, fig. 1a, b) and Teichert (1937, pl. 4, fig. 13, pl. 5, figs. 1, 2) correspond to those of *P. pattersoni*. There is little doubt that these representatives of “*P. lambei*” and the present species are conspecific.

The specific name is in honor of my colleague, Mr. Bryan Patterson.

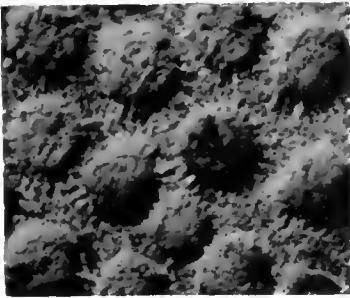
Horizon and locality.—Richmond. Silliman’s Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes, Ralph Robinson, and Sharat K. Roy.

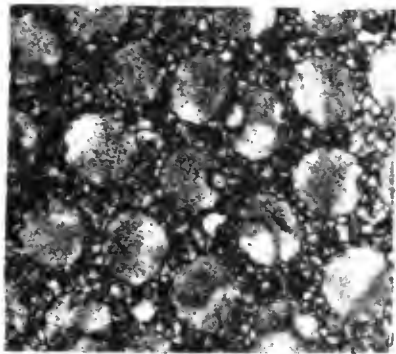
Holotype.—F.M. No. P28829.



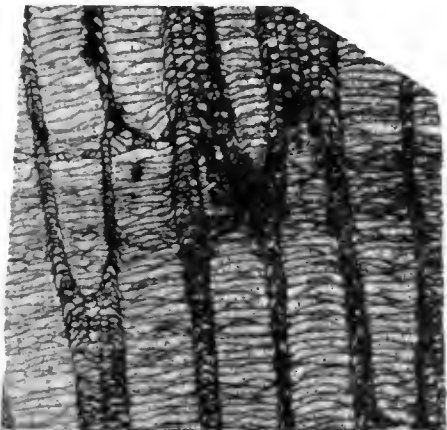
a



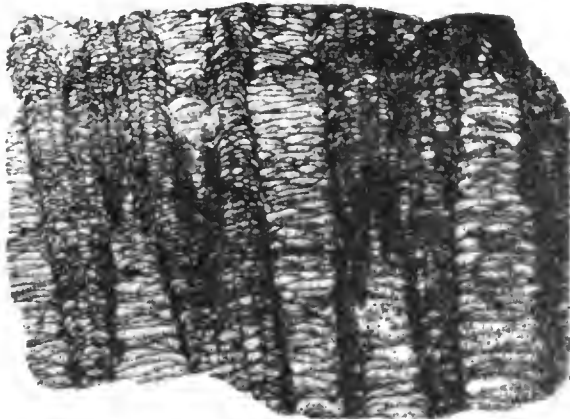
b



c



d



e

FIG. 37. *Plasmopora pattersoni* Roy, sp. nov. F.M. No. P28829. a, View of upper surface of a corallum; natural size. b, Enlarged corallites. c, Transverse section; $\times 4$. d, e, Longitudinal sections; $\times 4$.

Order *Tabulata*Family *Favositidae* Edwards and HaimeGenus *Calapoecia* Billings

This genus has been ably revised and redescribed recently by Cox (1936). He regards this coral as a somewhat aberrant Tabulate, "characterized by the presence of a very open stereozone bounding its corallite, and twenty short, wedge-shaped septa rising periodically from the septal ridges, which alone make the corallite 'wall.'" He further finds that there is but one species belonging to this genus, viz., *Calapoecia canadensis* Billings, from which arise three varieties, *C. canadensis* var. *ungava* (Cox), *C. canadensis* var. *anticostiensis* Billings, and *C. canadensis* var. *anticostiensis* f. *arctica* (Troedsson).

Calapoecia canadensis var. *anticostiensis* Billings

Calapoecia canadensis var. *anticostiensis* Billings. For a complete bibliography and synonyms see Ian Cox, Bull. Nat. Mus. Canada, 80, Geol. Ser. No. 53, p. 12, pl. 1, fig. 6, pl. 3, figs. 1a-c, 3d, 5a-c, 6, 7, 1936.

*Description*¹ (Cox, 1936, pp. 13-14).—"Major portion of a large mass, sliced transversely and polished. The surface shows radiating, circular corallites typically distant, a few in contact, with maximum diameter of 2.5 mm. The wall of each corallite is raised in a narrow rim from which twenty costae are distinctly seen to radiate, at a lower level, into the inter-corallite area. This area is depressed, but in some places rises to a subdued straight ridge between juxtaposed corallites; consequently the surface appears to be made up of polygonal units which contain a single corallite and its 'costae.' It must be said at once, however, that no trace of this ridge is to be observed in the internal structure.

"In thin sections each corallite is seen to be bounded by an open mesh-work made up of septal ridges, which are produced into short, wedge-like spines at regular intervals (about 8 spines in 5 mm.) and fused to their neighbors at these levels. A section taken at such an horizon of fusion will show a circular corallite with a continuous wall made up of septa, which are in contact for about two-thirds of their length and then taper fairly abruptly inward to an obtuse point. But each septal spine is continued outward and slightly downward beyond the corallite boundary into the coenenchyme as a 'costa.' When their bases are not seen in the section (it will be remembered that they incline slightly downward) these 'costae' will appear as rods or spindles of about 0.75 mm. in length, lying on a circle of greater diameter than that of the corallite and separated from their neighbors by more or less wide pores. But sections at a level slightly higher than this will show septa passing continuously out into 'costae.' This is most commonly seen within the zone of septal fusion so that the corallite showing this feature probably will have a solid 'wall.' But some pores may be cut at such a level. This variation in the appearance of thin section

¹Based on Billings' holotype of "*C. anticostiensis*," G.S.C. No. 2267 (*C. canadensis* var. *anticostiensis* Billings).

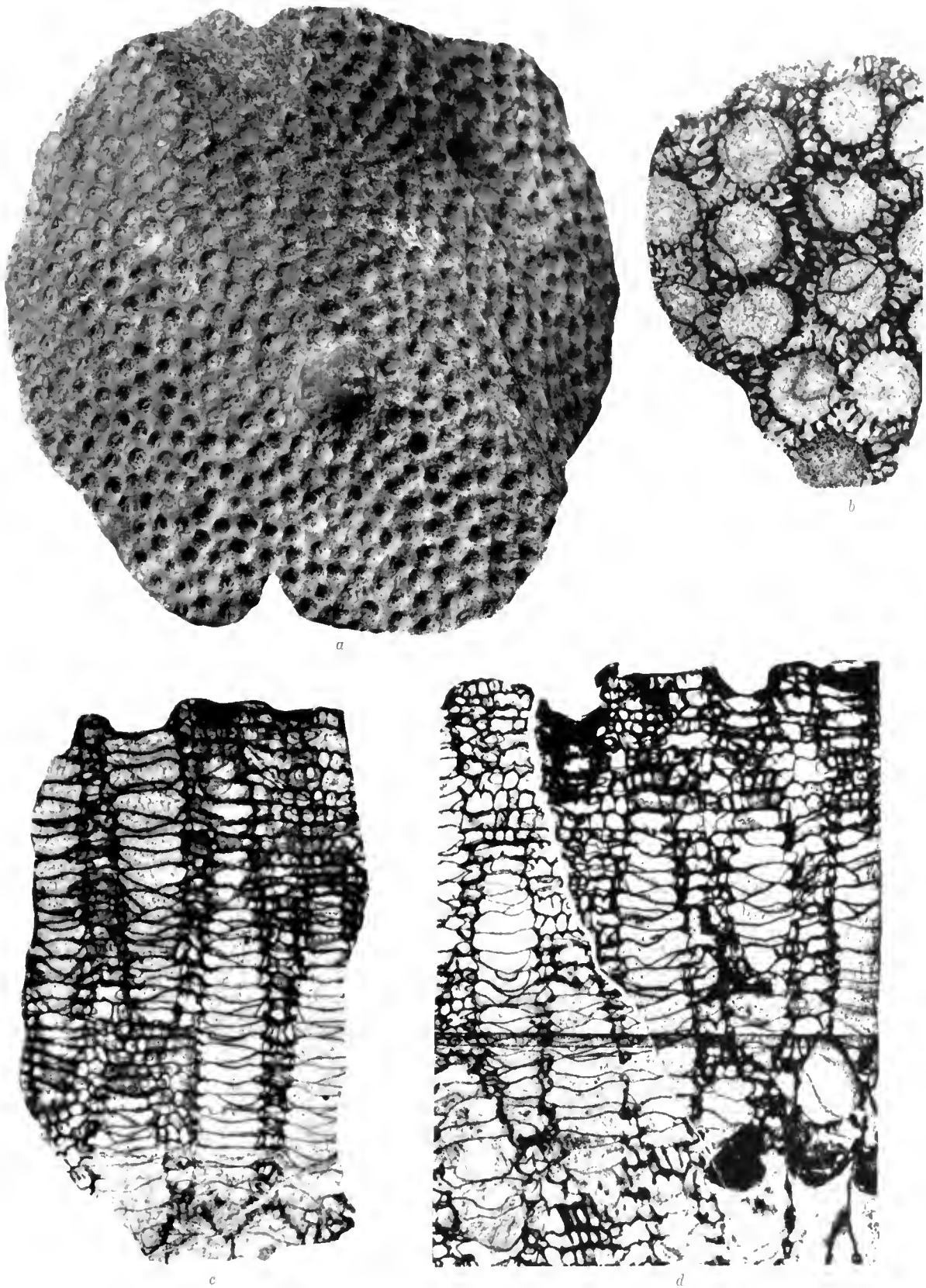


FIG. 38. *Calapoecia canadensis* var. *anticostiensis* Billings. F.M. No. P28830. *a*, Corallum from above; natural size. *b*, Transverse section; $\times 3\frac{3}{4}$. *c*, *d*, Longitudinal sections; $\times 3\frac{3}{4}$.

is tersely shown in Lambe's diagrammatic figure, Plate I, figure 6a (1899) [Contr. Canad. Paleont., Geol. Surv. Canada, 4, pt. I], which, however, is not elucidated in his text. But his reference of this figure to his figure 6, which is too generalized, is misleading.

"The mural pores, which lie on vertical and horizontal rows, are circular and probably have a diameter of no less than 0.25 mm. But the dilation of the septal spines and, to a less extent, of 'costae,' toward their bases, where they are fused to their neighbors, gives a funnel-like entrance to these pores. On account of the septal spines being arranged on horizontal and vertical rows, these 'funnels' have a rounded-quadrangular section at their widest part, but assume an oval, then circular, section as they lead into a pore. This, of course, happens within a very short distance, but it is important because certain authors have attached considerable weight to the shape of the pores in *Calapoecia*. This they have studied from the weathered interiors of corallites. It can be seen from the above description that the apparent shape of the pore in these cases will depend on the depth of weathering, and although a pore may appear to be quadrangular at first sight, it becomes clear, when the matrix is carefully removed with a needle, that this is the shape of the funnel-like entrance and not of the pore itself, which is circular. The term 'funnel' has been used merely to facilitate the making of this rather important point; of course it is not a structure, but only the result of the distribution and habit of the septal elements. These remarks are also applicable to longitudinal sections, where the pores will show a shape depending entirely on where the cut is made.

"The tabulae are both complete and incomplete. A central count gives ten to twelve in 5 mm. They may pass through pores into the coenenchyme, but are typically bent upward at the periphery of the corallite, crossing the face of a pore and joining one septal spine to that above it. These upturned tabulae may give the false appearance of a wall in a transverse section cut through a region of pores.

"The coenenchyme is well developed and consists primarily of horizontal elements which correspond fairly well with the number of tabulae in adjoining corallites and may commonly be continuous with these. Here and there curved plates run from one horizontal diaphragm to the next in a way exactly like the upturning of the tabulae at the periphery of the corallites. The 'costae' run into the coenenchyme and subdivide it vertically. The coenenchyme varies from regular and simple to a rather untidy arrangement within the single corallum."

Remarks.—The above description gives a complete picture of the specimens at hand. The surface of the Field Museum specimens, however, is worn, resulting in the smoothing down of the rim-like raised walls of the corallites to a considerable extent, thus making the radiating costae invisible except in thin sections.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes, Ralph Robinson, and Sharat K. Roy.

Family **Halisitidae** Edwards and HaimeGenus **Halysites** Fischer de Waldheim

Despite important contributions made by a number of investigators on *Halysites*, the difficulty of distinguishing species among individuals of that genus, or of segregating varieties under described species, has not been appreciably lessened. The difficulty seems to rest mainly on the astonishing variations, both in external and internal structures, that this coral presents to the investigator. Even in the same individual, the manner of growth of the corallites, their shape and size, the meshes of their reticulations, the spacing of the tabulae, and the character of the septal spines, if any, commonly are not the same. In fact, by examining thin sections from different portions of a single corallum it is not unusual to find greater variations among them than have been reported to exist between individuals that have been given specific or varietal rank.

Those familiar with the mode of skeletal growth and colony formation of modern corals realize that a temporary change in the physical or chemical conditions surrounding the corals may easily result in a change in their normal structural growth. The observed variations in specimens of *Halysites* indicate that similar changes commonly occurred in the past. The age of the corals is another important factor in variations. Many individuals commonly show unusual conditions in their oldest cells which, if observed by themselves, may be mistaken for essential specific characters. Unfortunately, however, these differences, obviously results of environment and age, have not been taken into consideration by some authors who have used such criteria for specific differentiation. As a result, not a few species have been placed on record that are of very doubtful validity.

Troedsson (1928, p. 130) has given a tentative table of classification in which he takes into consideration four pairs of features: (1) Presence or absence of tubuli; (2) presence or absence of septal spines; (3) small- or large-sized corallites; and (4) regular or irregular meshes. He believes that the application of these features or their combinations will be useful as one method of classification. Perhaps Troedsson's selection of diagnostic features would have been more complete if he had included among them a fifth pair, namely, whether or not the tabulae are closely or widely spaced. Nevertheless, his proposed criteria seem to offer greater possibilities for specific separation than have been hitherto recognized. Their application, however, will be of necessity limited, for the presence or absence of a pair or pairs of the above-mentioned determinative features may be observed in the same individual.

Halysites agglomeratiformis Whitfield

Halysites agglomeratiformis Whitfield, Bull. Amer. Mus. Nat. Hist., 13, p. 20, pl. 2, figs. 1, 2, 1900; Troedsson, Medd. om Grønland, 72, p. 133, pl. 46, fig. 1a-d, 1928.

Description.—Corallum massive, corallites radiating from the center of the base. Meshes of reticulations small, elongated, and irregular. Corallites more barrel-shaped than rectangular, being much narrower at the end than at the



FIG. 39. *Halysites agglomeratiformis* Whitfield. F.M. No. P28831. *a*, Corallum; natural size. *b*, Cross section; $\times 4$. *c*, Longitudinal section; $\times 4$.

center; walls relatively thick; longer diameter of corallites about 2 mm., transverse diameter about 1 mm. Tabulae complete, straight or more commonly concave, averaging about eighteen in a space of 10 mm. Intercorallite tubuli and septal spines not observed.

Remarks.—*Halysites agglomeratiformis* was first described by Whitfield (1900, p. 20). The holotype of that species together with three other species (*Receptaculites pearyi*, *Calapoecia borealis* and *Heleolites perelegans*) was collected from Cape Harrison, Princess Marie Bay, Ellesmere Land. Whitfield believed the horizon to be "the same as that of the New York Niagara or Clinton Group." The associated fauna, however, indicates that the horizon is late Ordovician rather than Niagaran. Whitfield's description of *H. agglomeratiformis* is too brief and his illustrations too indistinct for satisfactory comparison. I have, therefore, based the identification of the present species on Troedsson's description and illustrations.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Halysites cf. *H. gracilis* (Hall)

Halysites gracilis Troedsson, Medd. om Grønland, **72**, pp. 131–132, pl. 40, figs. 2, 3a, b, 1928; Hussey, Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, p. 71, pl. 1, fig. 4, 1928; Teichert, Rept. Fifth Thule Exped., 1921–24, Gyldendalske Boghandel, Nord. Forlag, **1**, pp. 55–56, pl. 7, figs. 3, 6, 1937 (for earlier references to literature and synonyms, see Bassler, Bull. U. S. Nat. Mus., **1**, p. 586, 1915).

This form is represented by only a small fragment of a corallum.

Description.—Corallum massive (inferred). Meshes of reticulations large, irregular, a few polygonal. Corallites large, rectangular (slightly wider at the

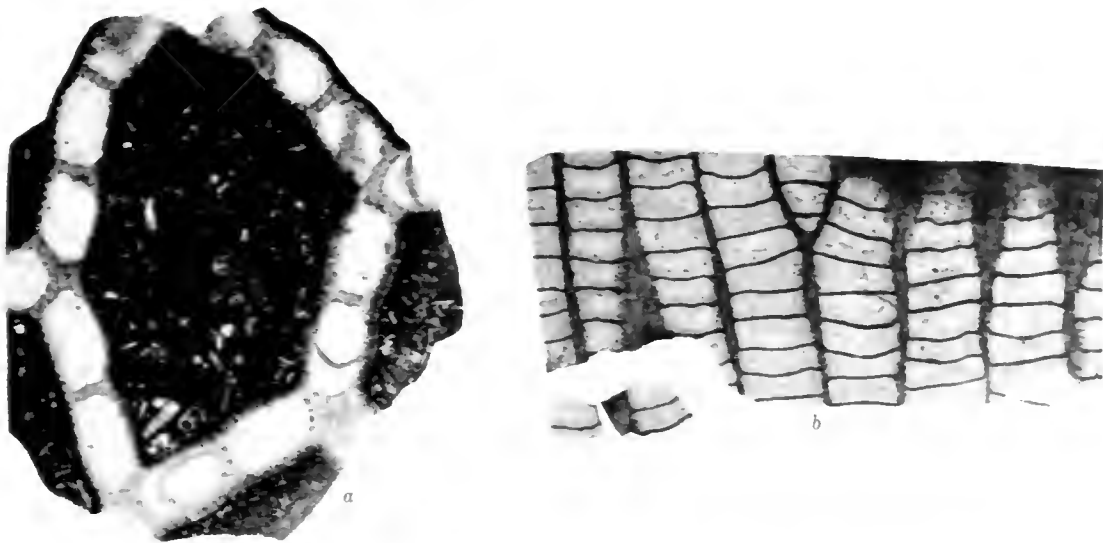


FIG. 40. *Halysites* cf. *H. gracilis* (Hall). F.M. No. P28832. *a*, Transverse section; approximately $\times 5$. *b*, Longitudinal section; $\times 4$.

center), with thick walls (0.5 mm.), average diameter of corallites 2.8 mm., transverse diameter 2 mm. Tabulae complete, averaging about nine in a distance of 8 mm., mostly straight, some inclined, a few concave. Septal spines very short, observed only in a few corallites. Intercorallite tubuli wanting.

Remarks.—This form has been referred to *H. gracilis* (Hall) rather than to *H. robustus* Wilson, which it more closely resembles, inasmuch as it is not certain whether *H. robustus* is a distinct species or one of the many variable forms of *H. gracilis*. Less quadrangular corallites, thicker walls, and heavier tabulae, which have been considered as distinguishing *H. robustus* from *H. gracilis*, have also been observed in the latter.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

Phylum ECHINODERMATA

Subphylum **Pelmatozoa** Leuckart

Class **Cystoidea** Leopold von Buck

Order **Rhombifera** Zittel

Family **Callocystidae** Bernard

Subfamily **Callocystinae** Jaekel

Genus **Cheirocrinus** Eichwald

Cheirocrinus sp.

Remarks.—The specimen is referable to the genus *Cheirocrinus* but it is too fragmentary for further consideration.



FIG. 41. *Cheirocrinus* sp. F.M. No. P28834. A fragment of a plate; $\times 5$.

Hitherto, in North America, no species of *Cheirocrinus* has been reported above the Trenton. The genus, however, occurs in the Richmond of Greenland, and, in Europe, in the Caradocian (probably equivalent to the Richmond) of Girvan district.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Class **Crinoidea** Miller

Crinoids, with the exception of the plates of *Carabocrinus* mentioned here below, are represented by a number of stems of different kinds. These stems are found in rocks that have been considerably weathered. The stems are predominantly circular in outline although a few with pentagonal outlines have been observed. Inasmuch as they can serve no useful purpose here, their inclusion seems unnecessary.

Order **Indunata** Wachsmuth and Springer
 Suborder **Fistulata** Wachsmuth and Springer
 Family **Cyathocrinidae** Roemer
 Subfamily **Carabocrininae**
 Genus **Carabocrinus** Billings

Carabocrinus sp.

Remarks.—Members of this genus have been reported from the Chazy to the Richmond in North America. The genus also has been reported from the Richmond of Greenland. In Europe one species, *Carabocrinus esthonus* Jaekel, has been described from Wassalem (probably Lower Utica) of Esthonia.

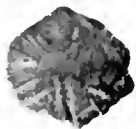


FIG. 42. *Carabocrinus* sp. F.M. No. P28833. A calyx plate; $\times 7$.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Phylum **MOLLUSCOIDEA**

Class **Bryozoa** Ehrenberg

Bryozoans are represented in this collection by five genera embracing six species. Of these, two forms, *Prasopora* sp. and *Batostoma* sp. are not illustrated here. Both were weathered, small fragments consisting of a few zooecia and were used up in the process of preparing them for identification. Besides the six species mentioned above, Dr. R. S. Bassler, while making a second study of a previous collection made at Silliman's Fossil Mount and described by Schuchert (1900), found six additional species, of which he identified two, *Nematopora ovalis* Ulrich and *Pachydietya pumila* Ulrich (Bassler, 1911, pp. 35-36).

Order **Trepostomata** Ulrich

Suborder **Amalgamata** Ulrich and Bassler

Family **Monticuliporidae** Nicholson

Genus **Atactoporella** Ulrich

Atactoporella cf. **A. schucherti** Ulrich

Atactoporella schucherti Ulrich. See Bassler, Bull. U. S. Nat. Mus., 1, p. 87, 1915, for references to literature and synonyms.

Remarks.—This species is represented by a small fragment of a zoarium. It is an incrusting form with petaloid to angular zooecia, numerous mesopores and small acanthopores indenting the zooecia. Its tangential section agrees well with the description of *Atactoporella schucherti* Ulrich from the Richmond of Ohio and Indiana but due to insufficient material it has not been possible to make a longitudinal section for comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

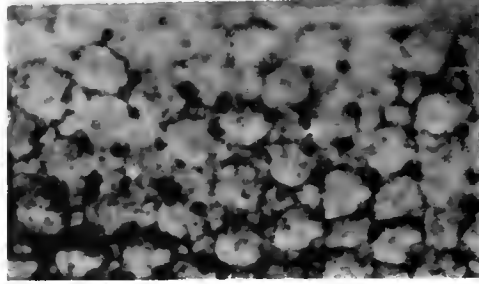


FIG. 43. *Atactoporella* cf. *A. schucherti* Ulrich. F.M. No. P28835. A small, naturally weathered fragment, showing zoecia, mesopores, and acanthopores; $\times 20$.

Collector.—Sharat K. Roy.

Family Constellariidae Ulrich

Genus *Dianulites* Eichwald

Dianulites sp.

Cf. *Dianulites petropolitanus* Dybowski. See Bassler, Bull. U. S. Nat. Mus., 1, pp. 405–406, 1915, for references to literature and synonyms.

Description.—Zoarium massive, almost always hemispheric, with an epitheated base varying from 20 to 40 mm. in width. Celluliferous side usually uneven

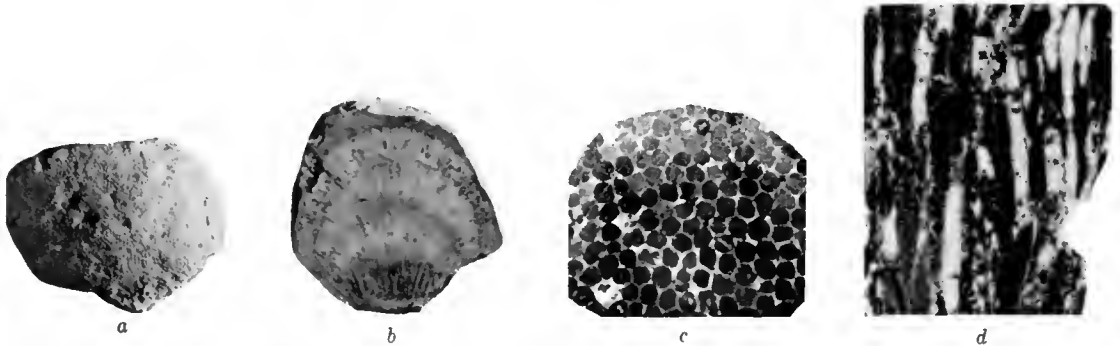


FIG. 44. *Dianulites* sp. F.M. No. P28836. *a*, Surface view; natural size. *b*, Polished vertical section; natural size. *c*, Tangential section; $\times 6$. *d*, Vertical section; $\times 6$.

but shows no especial structural arrangement. Zoecia thin-walled, hexagonal, polygonal, or rounded, averaging twelve in 5 mm. Diaphragms present but their distribution cannot be ascertained as most of the tubes are filled with sediments. Mesopores few. Acanthopores not observed.

Remarks.—This form resembles *Dianulites petropolitanus* Dybowski from the middle Ordovician of North America and Esthonia, but the unsatisfactory nature of the preservation of the zoecial tubes, as mentioned above, does not allow clearer observation for certain specific identification.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes and Sharat K. Roy.

Family **Batostomellidae** Ulrich

Genus **Eridotrypa** Ulrich

Eridotrypa bassleri Roy, sp. nov.

Cf. *Eridotrypa simulatrix* (Ulrich). See Bassler, Bull. U. S. Nat. Mus., 1, p. 496, 1915, for references to literature and synonyms.

Description.—Zoarium of cylindrical to somewhat flattened ramose branches. Zooecial apertures variable, oval, oblique or irregular, about seven in 3 mm., measuring longitudinally. Walls thick, highest posteriorly, sloping gradually

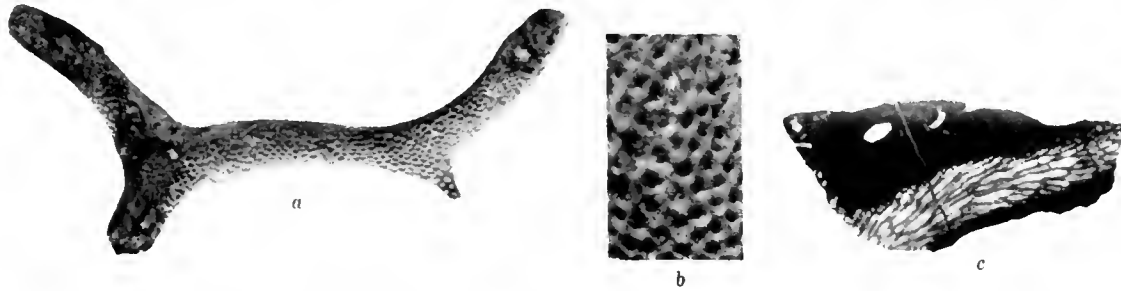


FIG. 45. *Eridotrypa bassleri* Roy, sp. nov. F.M. No. P28837. *a*, A portion of a zoarium; natural size. *b*, Part of the same; enlarged. *c*, Longitudinal section; $\times 4$.

down into the apertures. Diaphragms few on the axial region but fairly numerous on the peripheral zone. Mesopores sparsely scattered. Acanthopores absent.

Diagnosis.—In general appearance this species is suggestive of *Eridotrypa simulatrix* (Ulrich), from the Richmond. There are, however, certain apparent differences between the two which will serve to distinguish them readily from each other. The present species is a larger form with a less smooth surface, less regularly oval zooecia, and fewer diaphragms on the axial region.

Remarks.—The specific name is in honor of Dr. R. S. Bassler, of the United States National Museum.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28837.

Eridotrypa cf. **E. aedalis minor** (Ulrich)

Cf. *Eridotrypa aedalis minor* (Ulrich). See Bassler, Bull. U. S. Nat. Mus., 1, p. 495, 1915, for references to literature and synonyms.

Description.—Zoarium of slender, cylindrical, ramose branches averaging 2 mm. in diameter. Zooecial apertures oblique and conspicuously drawn out anteriorly. Walls thick, highest posteriorly, sloping into the apertures. Interspaces between zooecia canaliculate, resembling channeled interspaces charac-

teristic of the genus *Bythopora*. Diaphragms more numerous in the peripheral region than on the axial region. Mesopores few. Acanthopores not observed.

Remarks.—This bryozoan is represented by a few presumably young specimens. Externally it does not quite appear like the species to which it has been



FIG. 46. *Eridotrypa* cf. *E. aedalis minor* (Ulrich). F.M. No. P28838. *a*, A fragmentary specimen; $\times 2$. *b*, Enlargement of a portion of the same specimen.

referred for comparison, but its internal structures are very similar. Ulrich and Bassler have examined this form. The latter writes: "We were able to study the fragmentary bryozoan together and we agree that it is an *Eridotrypa* described by him [Ulrich] as *E. mutabilis* var. *minor*, now known as *aedalis minor* as you will note in my Bulletin 92, where also you will note that it is a Lower Trenton species in this country and a Middle Ordovician one in Esthonia. Your photograph, if it is of the same branch, appears to represent something different, but possibly it is due to a worn condition of the species."

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Class **Brachiopoda** Dumeril

The brachiopods are represented in the collection by fourteen genera embracing twenty-five species or varieties. All these are articulate forms belonging to the orders Protremata and Telotremata. Of the Order Protremata there are eleven genera represented, namely, *Plectorthis*, *Platystrophia*, *Skenidioides*(?), *Hesperorthis*, *Glyptorthis*, *Austinella*, *Dalmanella*, *Parastrophinella*, *Rafinesquina*, *Sowerbyella*, and *Strophomena*, and of Telotremata, three, *Rhynchotrema*, *Zygospira*, and *Cyclospira*. Most of the specimens are fairly well preserved, but unfortunately the different species are represented by only a few specimens, commonly by a single one.

Of the twenty-five species and varieties mentioned above, eighteen are new; one, *Glyptorthis bellarugosa* (Conrad), has already been described; and because of their fragmentary condition the remaining six can neither be referred definitely to any known species nor advantageously described as new.

Order **Protremata** Beecher
 Suborder **Orthoidea** Schuchert and Cooper
 Superfamily **Orthacea** Walcott and Schuchert
 Family **Plectorthidae** Schuchert and Cooper
 Subfamily **Plectorthinae** Schuchert
 Genus **Plectorthis** Hall and Clarke

Plectorthis inaequiconvexa Roy, sp. nov.

Description.—Transversely suboval or truncato-suboval; valves nearly equal; of medium size; wider than long, length of holotype 14.6 mm., width at the hinge line 15.6 mm., maximum width 19 mm., maximum convexity 7 mm.

Ventral valve convex, the greatest elevation being at the umbo. Lateral slopes more abrupt than the frontal slope. Beak a little arched and projecting

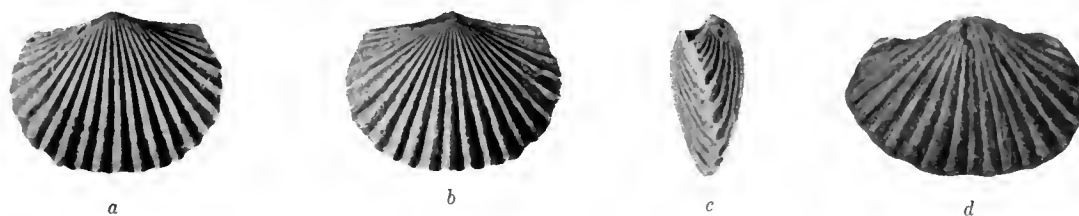


FIG. 47. *Plectorthis inaequiconvexa* Roy, sp. nov. *a, b, c*, Ventral, dorsal, and lateral views of holotype. U.S.N.M. No. 28151. *d*, Ventral view of a different individual. F.M. No. P28258. All $\times 1\frac{1}{2}$.

but not incurved. Cardinal area well defined, broadly triangular and moderately convex; extremities angular.

Dorsal valve much less convex than the ventral. Its greatest elevation is also at the umbonal region. Lateral and frontal slopes less pronounced than those of the opposite valve.

Surface marked by about twenty-six strong, coarse, and simple plications, and all crossed by concentric lines (posterior ones obsolete, apparently due to weathering of the shell).

Diagnosis.—This species shows close kinship to *Plectorthis plicatella* (Hall) and *P. plicatella trentonensis*¹ Foerste, but differs from both in having the ventral valve much more convex than the dorsal. This is best seen in lateral view (fig. 47, *c*) in which it is almost identical with that of *Hebertella borealis* (Billings). Furthermore, in the arctic species, the interspaces between the radiating plications, particularly at the front, are wider. The plications themselves are all simple. No increase by implantation has been observed.

Remarks.—There are three other specimens of this species in the United States National Museum (U.S.N.M. No. 28151). All were identified as *Orthis* (*Hebertella*) *borealis* (Schuchert, 1900, p. 157), perhaps because of their similarity to that species in lateral view.

¹The only difference between *P. plicatella* and its variety *trentonensis* seems to be that the latter is "more constant in the absence of secondary plications." (Foerste, 1910, p. 49.)

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—The United States National Museum specimens were collected by J. N. Carpender and R. W. Porter; the Field Museum specimen was collected by Sharat K. Roy.

Holotype.—U.S.N.M. No. 28151.

Subfamily **Platystrophiinae** Schuchert

Genus **Platystrophia** King

Platystrophia magnisulcata Roy, sp. nov.

Platystrophia biforata (not Schlotheim) Schuchert, Proc. U. S. Nat. Mus., **22**, p. 158, 1900.

Diagnosis.—This species closely resembles *Platystrophia elegantula triplicata* McEwan except that in the arctic species the hinge extremity is less acuminate,



FIG. 48. *Platystrophia magnisulcata* Roy, sp. nov. U.S.N.M. No. 28154. Holotype. *a, b, c, d*, Ventral, dorsal, frontal, and lateral views, respectively; $\times 1\frac{1}{3}$.

the fold more pronounced, and the sulcus much deeper. Dorsal valve also flatter. These differences are so apparent that a new specific name seems desirable.

Remarks.—Besides the holotype there is another specimen of this species in the United States National Museum.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—J. N. Carpender and A. H. White.

Holotype.—U.S.N.M. No. 28154.

Family **Skenidiidae** Kozłowski

Genus **Skenidioides** Schuchert and Cooper

Skenidioides(?) sp.

Description.—Shell very small, length 2.3 mm., width 3 mm. Semi-elliptical in outline, the greatest width along the hinge line.

Ventral valve subpyramidal, greatest elevation at the beak, then sloping almost uniformly at a steep angle to the lateral and front margins. Beak erect(?), cardinal area broadly triangular, apsacline. Delthyrium large and open. Dorsal valve depressed-convex, the sulcus originating at the beak and rapidly widening towards the front.

Surface ornamented with a few low, flat plications which are undivided and characterized by being dotted with granules and marked by very fine lines.

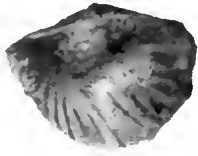


FIG. 49. *Skenidioides(?)* sp. F.M. No. P28259. Dorsal view; $\times 6$.

Remarks.—This form is represented by a single imperfect specimen. The beak is partially broken, the cardinal area somewhat obscured by calcareous incrustations, and the plications, except on the lateral sides, are ill defined. It somewhat resembles *S.(?) merope* (Billings) and *S. anthonense* Sardeson, and although it can be distinguished from both by its general shape and surface ornamentation, it is not sufficiently well preserved for comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family Orthidae Woodward

Subfamily Hesperorthinae Schuchert and Cooper

Genus Hesperorthis Schuchert and Cooper

Hesperorthis interplicata Roy, sp. nov.

Orthis tricenaria (not Conrad) Schuchert, Proc. U. S. Nat. Mus., 22, p. 156, 1900.

Diagnosis.—In general, this species answers the description of *Orthis tricenaria* Conrad, except that its plications are not simple but implanted at the



FIG. 50. *Hesperorthis interplicata* Roy, sp. nov. *a, b, c*, Ventral, dorsal, and cardinal views of holotype. U.S.N.M. No. 28149. *d*, Ventral valve of a different individual (A.M.N.H. specimen). All $\times 1\frac{1}{3}$.

beaks between the primary ones, and that it has more elevated median ridges on its ventral valve. These differences seem to be of sufficient importance to warrant a new name.

Remarks.—There are two specimens of this species in the collection. Of these, one is fairly complete, the other damaged in several places. Both are young individuals but are nevertheless identical with two specimens (U.S.N.M. No. 28149) collected from Silliman's Fossil Mount and described by Schuchert as *Orthis tricenaria* Conrad. Another, larger specimen (fig. 50, *d*), also collected from Silliman's Fossil Mount and identified as *O. tricenaria* Conrad, is now in the American Museum of Natural History. It was examined and found to be the same as the present species, *Hesperorthis interplicata* Roy.

Since the specimens in the United States National Museum are better preserved, one of them has been designated as holotype.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—The specimens in the United States National Museum were collected by J. N. Carpender, the Field Museum ones by Sharat K. Roy, and the one in the American Museum of Natural History was collected by R. W. Porter.

Holotype.—U.S.N.M. No. 28149.

Subfamily **Glyptorthinae** Schuchert and Cooper

Genus **Glyptorthis** Foerste

Glyptorthis bellarugosa (Conrad)

See Bassler, Bull. U. S. Nat. Mus., 2, p. 591, 1915, for references to literature and synonyms.

Remarks.—A single representative of this species from Silliman's Fossil Mount is now in the American Museum of Natural History (A.M.N.H. No. 4800). It is almost identical with *Hebertella* (*Glyptorthis*) *bellarugosa* (Conrad



FIG. 51. *Glyptorthis bellarugosa* (Conrad). A.M.N.H. No. 4800. *a, b, c, d*, Ventral, dorsal, cardinal, and lateral views, respectively; $\times 1\frac{1}{2}$.

sp.) from Mineral Point, Wisconsin, and may be conspecific with it. The only difference observed between the two is that the sulcus of the dorsal valve in the arctic species is a little less pronounced at the front margin. This minor difference is perhaps an individual variation rather than specific or varietal.

Foerste (1914, p. 258) distinguishes *Hebertella* from *Glyptorthis* by the lamellate shell structure in the former genus. In the specimen considered here no lamellose growth lines have been observed.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—R. W. Porter.

Family **Dinorthidae** Schuchert and Cooper

Genus **Austinella** Foerste

Austinella cooperi Roy, sp. nov.

Orthis (*Plectorthis*) *plicatella* (not Winchell and Schuchert) Schuchert, Proc. U. S. Nat. Mus., 22, p. 156, 1900.

Description.—Shell subquadrangle; the largest one (holotype) of the ten specimens (one in Field Museum and nine in the United States National Museum)

is 18.5 mm. in length, 23.5 mm. in width, and 10 mm. in maximum convexity; the smallest one (paratype) is 9 mm. in length, 11.4 mm. in width, and 4.2 mm. in maximum convexity.

Ventral valve strongly convex, the convexity decreasing gradually anteriorly to a shallow, almost imperceptible, wide sulcus. Beak small, slightly incurved; cardinal area arched, extremities not extended beyond the greatest width of the valve. Surface marked by strong, rounded ribs which increase by implantation in the umbonal regions, and all crossed by imbricating growth lines. The number

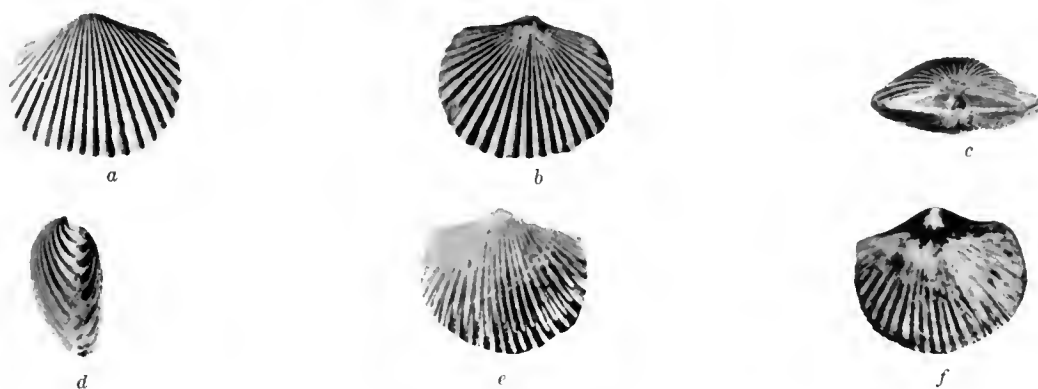


FIG. 52. *Austinella cooperi* Roy, sp. nov. *a, b, c, d*, Ventral, dorsal, cardinal, and lateral views, respectively, of holotype. U.S.N.M. No. 28150. *e, f*, Ventral and dorsal views of a different individual. F.M. No. P28261. All natural size.

of radiating plications counted on the anterior margin of the youngest specimen is twenty-two; of the largest specimen, the holotype, twenty-six. This number, however, varies with the individuals. The Field Museum specimen, which is smaller than the holotype, has twenty-eight plications.

Dorsal valve slightly convex; median sulcus shallow, almost linear at the beak, but widening rapidly anteriorly to the front margin. In young specimens the sulcus is barely visible.

Diagnosis.—Of the three described species of the genus *Austinella*, only *A. scovillei* Miller has some resemblance to the present species. The differences between the two, however, are apparent, and *A. cooperi* Roy, with its flatter form, fewer ribs, and less extended cardinal extremities, readily stands out as a distinct species.

Remarks.—Since the largest specimen among nine of this species in the United States National Museum is the best-preserved one and superior to the Field Museum specimen, I have elected it as holotype. So far as is known, no species of the genus *Austinella* has previously been reported below the Richmond.

The specific name is in honor of Dr. G. Arthur Cooper, of the United States National Museum.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—The Field Museum specimen was collected by Sharat K. Roy and those in the United States National Museum were collected by J. N. Carpenter.

Holotype.—U.S.N.M. No. 28150.

***Austinella*(?) *subcircularis* Roy, sp. nov.**

Plectorthis fissicosta (Hall) (labeled as *P. fissicosta* Meek, in the American Museum of Natural History).

This species is represented by two fairly well-preserved specimens,¹ both in the American Museum of Natural History.

Description.—Shell subcircular, the smaller one (holotype) 16.5 mm. in length, 20 mm. in width, and 7.5 mm. in maximum convexity; the larger one,

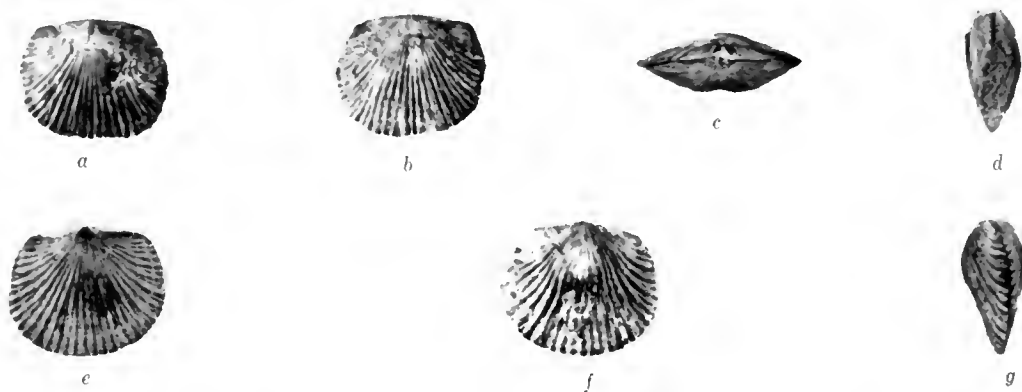


FIG. 53. *Austinella*(?) *subcircularis* Roy, sp. nov. *a, b, c, d*, Ventral, dorsal, cardinal, and lateral views, respectively, of holotype. A.M.N.H. No. 4797. *e, f, g*, Ventral, dorsal, and lateral views of paratype. All natural size.

which has a bulge at the umbonal region apparently due to mechanical pressure, 18 mm. in length, 21.5 mm. in width, and 9 mm. in maximum convexity.

Ventral valve moderately convex, the convexity decreasing gradually anteriorly to a wide, shallow sulcus. Beak small, slightly turned outward. Cardinal area a little arched, extremities rounded. Surface marked by rounded ribs which increase by bifurcation and implantation on the anterior portion. The number of ribs ($46 \pm$) is greater than observed in a specimen of equal size of *A. cooperi* Roy.

The dorsal valve is equally or slightly more convex than the ventral. The character of the median sulcus is the same as that of the preceding species, *A. cooperi*. In the paratype the median sulcus is obscured by the tension produced by the umbonal bulge mentioned above.

Diagnosis.—In general aspect the present species somewhat resembles *Austinella kankakensis* (McChesney). This relationship, however, seems superficial when individual characters are compared. The arctic species is a smaller

¹Plaster casts of the holotype and paratype are in the Field Museum collection (F.M. Nos. P28262 and P28262A, respectively).

form having more rounded extremities and fewer plications. Its dorsal valve is also much more convex than that of *A. kankakensis*.

Remarks.—The doubtful reference of this species to *Austinella* is due to the fact that no interior of the pedicle valve of the shell is available and hence the narrow, rectangular muscular area believed to be the most important diagnostic character of this genus cannot be examined. The outward form and general appearance of this species, however, show stronger affinity to *Austinella* than to *Plectorthis*, *Dinorthis*, or *Hebertella*. *Plectorthis fissicosta* (Hall), with which this species was previously identified, is, as pointed out by Foerste (1910, p. 48), "characterized by the great prominence of the primary plications, causing them to appear widely separated, especially along the middle parts of the shell." This is not the case with *A. (?) subcircularis* Roy, in which the primary as well as the secondary (implanted) plications are more or less of equal prominence; at least, the difference is not conspicuous.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—R. W. Porter.

Holotype.—A.M.N.H. No. 4797.

Superfamily **Dalmanellacea** Schuchert and Cooper

Family **Dalmanellidae** Schuchert

Genus **Dalmanella** Hall and Clarke

Dalmanella diminutiva Roy, sp. nov.

Description.—Shell subcircular, small, a nearly perfect specimen (holotype) being 8 mm. wide and 7.5 mm. long. Hinge line shorter than the greatest width of the valves.

Ventral valve strongly convex, the surface sloping gradually and rather evenly in all directions. Median fold, consisting of four plications, scarcely discernible. Beak incurved, projecting over the cardinal area, which is high.

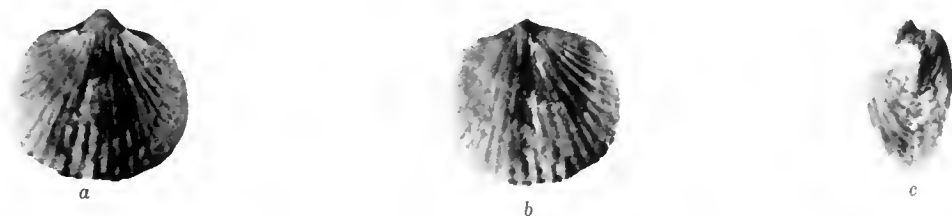


FIG. 54. *Dalmanella diminutiva* Roy, sp. nov. F.M. No. P28263. Holotype. *a*, *b*, *c*, Ventral, dorsal, and lateral views, respectively; $\times 3$.

Dorsal valve slightly convex, the greatest elevation posterior to the middle. A median sulcus, which commences very narrow at the beak, rapidly widens, and becomes undefined anteriorly.

Surface ornamented with about forty coarse, rounded radiating plications which bifurcate twice and increase by implantation between the beak and the free margins and all crossed by a few concentric lines of growth.

Diagnosis.—The closest allied form to this species is *Dalmanella* cf. *D. testudinaria* (Dalman) of Troedsson (1928, pp. 82–83, pl. 20, figs. 2a–c, 3). Troedsson, however, does not describe his specimens in sufficient detail to insure satisfactory comparison. He concludes with the following remark (p. 83): “The American specimens [*D. testudinaria*] I have studied belong to the same general type, it is true, but they do not seem to be identical. The Cape Calhoun shells are dwarf forms. Their relations to the American ‘*Dalmanella testudinaria*’ cannot be determined without a closer study of the latter, which has not yet been performed.” It is well known that in America *D. testudinaria* is not regarded as a definite species. It represents a variety of forms and as such any reference to it without mention of a particular form is of little comparative or diagnostic value.

The present species also appears to be a dwarf form, but it differs from Troedsson’s species in being more rotund and in having fewer, coarser, and less sharp plications. The ventral fold as well as the corresponding dorsal sulcus is also much less conspicuous in this species.

Horizon and locality.—Richmond. Silliman’s Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28263.

***Dalmanella sillimani* Roy, sp. nov.**

Description.—Shell subquadrangular to subcircular in outline, small, the largest one (holotype) of the five specimens in the present collection being 12.3 mm. long, 14 mm. wide. Hinge line shorter than the greatest width of the valves.

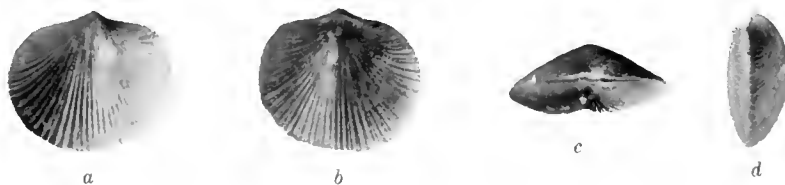


FIG. 55. *Dalmanella sillimani* Roy, sp. nov. F.M. No. P28264. Holotype. *a, b, c, d*, Ventral, dorsal, cardinal, and lateral views, respectively; $\times 1\frac{1}{2}$.

Ventral valve strongly convex, the surface sloping in all directions at a moderately steep angle from the median ridge, which is highest posteriorly. Beak incurved, projecting slightly over the cardinal area, which is high and inclined towards the dorsal valve.

Dorsal valve slightly convex. Beak nearly straight. Cardinal area not as high as that of the ventral valve. Median sulcus begins narrow at the beak, widening rapidly anteriorly. It is sharpest near the beak.

Surface marked by about 100 subrounded radiating plications, the result of repeated implantations and bifurcations of about fifteen principal striae which reach the apex. These plications are all crossed by faint concentric lines of growth. In younger specimens, which are usually rotund, the concentric lines are still less pronounced except near the margins.

Diagnosis.—Of the related species compared with the present one the following three, *Dalmanella rogata* (Sardeson) from the Black River and Trenton, *Dalmanella corpulenta* (Sardeson) from the Richmond, and *Dalmanella ignota* (Sardeson), also from the Richmond, show the closest affinity. It, however, differs from these species in having a greater number of plications. Individually, it differs from *D. rogata* in having a more convex dorsal valve and less disproportionate cardinal areas between the two valves; from *D. corpulenta* in being more quadrangular in outline; and from *D. ignota* in being less quadrangular and in having a less well-defined median ridge and a more convex dorsal valve. Unfortunately, there are no interiors of either valve of the present species at hand, and it has not, therefore, been possible to compare its internal characters with those of the three species just mentioned. The similarities of its exterior characters, however, are so striking that it would seem to have evolved from a not far distant ancestral form common to any or all three species here compared.

Remarks.—Besides the holotype there are four paratypes (F.M. No. P28265) in the present collection. A number of specimens belonging to this species (identified as *D. testudinaria*, U.S.N.M. No. 28148) are in the United States National Museum. All specimens of this species, so far seen, are extremely well preserved. The adhering clayey matrix of practically every specimen examined indicates that the specimens were weathered out of a clayey facies of the deposit.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28264.

Dalmanella(?) sp.

Description.—A partly preserved dorsal valve of a young species. The valve is convex and subtriangular. The sulcus, with three plications, the outside two being implanted, begins at the beak and gradually widens to the front margins. Surface marked by bifurcating plications.

Remarks.—The above characters are the only ones that can be seen in the specimen. Consequently, it cannot be compared with any known species. The observable characters are also not sufficient to make the generic identification certain.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

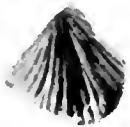


FIG. 56. *Dalmanella*(?) sp. F.M. No. P28266. An incomplete dorsal valve; $\times 3$.

Suborder **Pentameroidea** Schuchert and Cooper
 Superfamily **Pentameracea** Schuchert
 Family **Camarellidae** Hall and Clarke
 Genus **Parastrophinella** Schuchert and Cooper

Parastrophinella hemiplicata minor Roy, var. nov.

Parastrophia hemiplicata (not Hall) Schuchert, Proc. U. S. Nat. Mus., **22**, p. 158, 1900.

Diagnosis.—The arctic examples of this variety of *Parastrophinella hemiplicata* (Hall), of which there are five specimens in the United States National

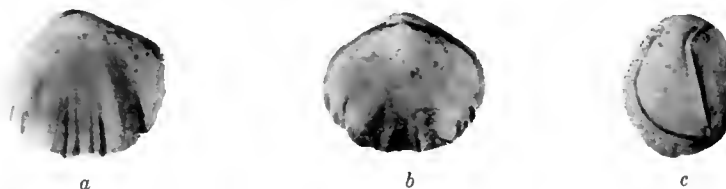


FIG. 57. *Parastrophinella hemiplicata minor* Roy, var. nov. U.S.N.M. No. 28156. Holotype. *a*, *b*, *c*, Ventral, dorsal, and lateral views, respectively; $\times 2$.

Museum, differ from the typical *P. hemiplicata* from the Trenton of New York chiefly in being undersized and relatively less wide than long. These characters, however, are constant and seem sufficient to warrant a varietal name.

Remarks.—The holotype and four paratypes (U.S.N.M. No. 28156) are in the United States National Museum.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—A. H. White.

Holotype.—U.S.N.M. No. 28156.

Superfamily **Strophomenacea** Schuchert

Family **Strophomenidae** King

Subfamily **Rafinesquininae** Schuchert

Genus **Rafinesquina** Hall and Clarke

Rafinesquina pronis Roy, sp. nov.

Description.—Shell small, the holotype being 16 mm. long and 22.5 mm. wide. Semi-circular in outline. Hinge line a little shorter than the greatest width of the shell, lateral margins rounding to the front. Beak small, projecting slightly over the cardinal area.

Ventral valve slightly convex at the umbonal region, bending abruptly (laterally and anteriorly) almost at right angles at about two-thirds the distance from the beak. This abrupt flexure gives the valve a very strongly convex appearance on the anterior and lateral views. Surface marked by fine, low, rounded, radiating plications of nearly uniform size (a few at the front are

larger), increased towards the margins by bifurcation and implantation and crossed by very fine elevated concentric lines and wrinkles. The median radiating rib is more conspicuous than any of the remainder, such as may be seen in *R. declivis* (James), *R. squamula* (James), and *R. mucronata* (Foerste).



FIG. 58. *Rafinesquina pronis* Roy, sp. nov. *a*, Ventral valve of holotype. F.M. No. P28267. *b*, Interior of dorsal valve of paratype. F.M. No. P28268. Both $\times 1\frac{1}{3}$.

Dorsal valve conforms with the curvature of the ventral valve. The entire surface of the interior is dotted with irregularly placed granules of varying size.

Diagnosis.—This species closely resembles *R. declivis* (James) in the abrupt downward flexure of its frontal and lateral margins and in the presence of a prominent median rib in the ventral valve. Otherwise, it is notably dissimilar and can be distinguished by its semi-circular outline and by the lack of prominence of every fourth, fifth, or sixth radiating plication.

Remarks.—There are five specimens of this species in the Museum collection, of which only two, a ventral valve (holotype) and an interior of a dorsal valve, apparently belonging to two different individuals, are well preserved.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Sharat K. Roy and Ralph Robinson.

Holotype.—F.M. No. P28267.

Rafinesquina declivis subnutans Roy, var. nov.

Description.—Shell small, wider than long, width 17 mm., length 15 mm. Suboval in outline. Hinge line straight, shorter than the width of the shell.

Ventral valve convex, most elevated medially and at the umbonal region, the surface sloping almost to flatness (slightly reflected near the cardinal extremi-

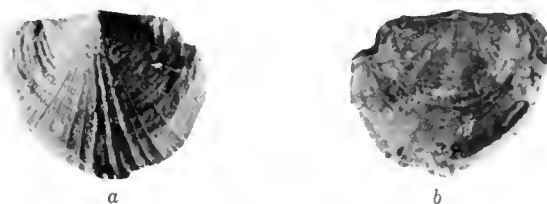


FIG. 59. *Rafinesquina declivis subnutans* Roy, var. nov. F.M. No. P28269. Holotype. *a*, *b*, Ventral and dorsal views, respectively; $\times 1\frac{1}{3}$.

ties), thence deflecting abruptly at a short distance from the lateral and front margins. Beak scarcely produced over that of the opposite valve. Cardinal area narrow, linear.

Radiating plications subangular, distinctly alternate, three to nine finer lines between the stronger ones increasing towards the margin by bifurcation and implantation and all crossed by fine concentric lines as well as by elevated wrinkles. Dorsal valve concave, corresponding to the curvature of the ventral valve. Surface marked by nearly equal radiating plications which, as in the opposite valve, are all crossed by fine, concentric lines and elevated wrinkles.

Diagnosis.—This variety is more closely allied to *Rafinesquina declivis* (James) than is the preceding one, *R. pronis* Roy. It has, however, a larger flat area, and its downward flexure is not so abrupt. Furthermore, it does not have the prominent median rib on the ventral valve characteristic of *R. declivis*. These differences, although noticeable, are not significant enough for specific differentiation. A varietal distinction, however, seems desirable.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28269.

***Rafinesquina productiformis* Roy, sp. nov.**

Description.—Shell small; outline suboval. Length and width, as far as preserved, 13.3 mm. and 16 mm., respectively.

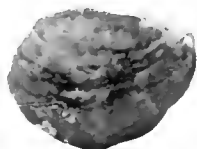


FIG. 60. *Rafinesquina productiformis* Roy, sp. nov. F.M. No. P28270. Holotype. Ventral valve; $\times 1\frac{1}{2}$.

Ventral valve strongly convex; umbo greatly incurved, giving it a productoid form. Hinge line a little inflected; cardinal area narrow, linear.

Surface covered with irregular, wavy, rounded plications and all crossed by concentric lines and wrinkles.

Diagnosis.—Although this species is known only from a ventral valve it can be readily distinguished from all other described species of the genus by its conspicuous incurved umbonal region.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28270.

***Rafinesquina* sp.**

Description.—Shell small; wider than long, width 19 mm., length 16 mm. Subtrigonal in outline.

Ventral valve strongly convex, the greatest convexity at the middle, the surface sloping rapidly in all directions. Hinge line straight, extending beyond

the width of the shell. Cardinal area narrow, linear; extremities slightly reflected. Beak projecting over the cardinal area.

Surface obscured by calcareous incrustations, only a few stronger costae discernible at the middle. The interior is covered with papillae as evidenced by punctate structures on the exfoliated surface around the posterior region.

Dorsal valve not observed.



FIG. 61. *Rafinesquina* sp. F.M. No. P28271. Ventral valve; $\times 1\frac{1}{3}$.

Remarks.—In general appearance this shell approaches *R. deltoidea* (Conrad), especially the smaller forms, having regular convexity from the umbo to the anterior margin, but differs from it in the absence of rugose undulations on the surface of the disk characteristic of *R. deltoidea*. In the absence of the dorsal valve and because of the poor condition of the ventral valve it has not been possible to compare this specimen with any other known species.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Sowerbyella* (Sowerby)

Sowerbyella sp.

Plectambonites serecea(?) (Sowerby). See Bassler, Bull. U. S. Nat. Mus., 2, p. 997, 1915, for references to literature and synonyms.

Remarks.—Several specimens of *Sowerbyella* are in the collection. They vary in size, the largest one being 11 mm. long and 18 mm. wide and the smallest measurable one 4.3 mm. long and 7.5 mm. wide. Whether all these specimens

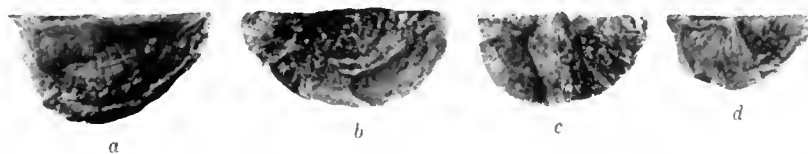


FIG. 62. *Sowerbyella* sp. F.M. No. P28272. a, b, c, Different individuals. d, Internal mold. All enlarged about $1\frac{1}{3}$.

belong to one species cannot be definitely determined, although it appears almost certain that they represent more than one. Specific determination, however, has not been attempted, for such an attempt, until further revision of the many species and varieties described under this genus (O. T. Jones, 1928) is made, is likely to be uncertain and new names will only add to the confusion now existing.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Sharat K. Roy, John Jaynes, and Ralph Robinson.

Subfamily Orthotetinae Waagen

Genus *Strophomena* (*Rafinesquina*) Blainville*Strophomena undulosa* Roy, sp. nov.

Description.—Shell of medium size, subtriangular in outline; length 17.5 mm., width 21 mm. Widest at hinge line; nasute in front. Dorsal valve convex, somewhat flat posterior to the middle, the remainder curving abruptly downward.

Surface ornamented with alternating plications, the finer ones indistinct and undefined, and all crossed by concentric, undulating wrinkles. The wrinklings



FIG. 63. *Strophomena undulosa* Roy, sp. nov. *a*, Dorsal valve of holotype. F.M. No. P28273. *b*, Interior of ventral valve from Marshbrook, Shropshire, England. F.M. No. P10840. Both natural size.

are most conspicuous on the posterior half of the valve; the remainder shows little regularity and in places is longitudinally wrinkled.

Diagnosis.—This species appears almost identical with *Strophomena fluctuosa* Billings as figured by Troedsson (1928, pl. 22, fig. 13), but it is doubtful if his specimen is conspecific with *S. fluctuosa*. So far as they are visible in the illustrations, the differences between Troedsson's specimen and those figured by other authors (Bassler, 1915, 2, p. 1228) are too great to be attributed to the same species. The wrinkling in *S. fluctuosa* is more or less confined to the posterior flat portion, whereas in Troedsson's specimen, as well as in the present one, the wrinkling extends over the entire surface of the shell.

It may be suggested that the difference in wrinklings in the arctic specimens is the result of unequal pressure, yet the fact that two specimens with identical wrinklings have been found in two widely separated localities is a strong argument against such a conclusion. The wrinkling appears to be characteristic¹ rather than an abnormality. Of the described species, *Strophomena trilobata* (Owen) seems to show the closest relationships with the present species as well as with the one figured by Troedsson (1928, pl. 22, fig. 13). Both of these arctic forms, however, can be readily distinguished from *S. trilobata* by their characteristic wrinklings.

¹ While this paper was in progress, a third specimen, F.M. No. P10840 (an interior of a ventral valve, fig. 63, *b*), of similar form and having the same characteristic wrinklings, was found in a small collection of invertebrate fossils received by exchange from the University of Bristol, England, in 1910. The specimen was collected at Marshbrook, Shropshire, England, and incorrectly labeled as *Leptaena rhomboidalis* (Wilckens). The Marshbrook specimen is very similar to the arctic form, differing only in the character of plications, which are almost uniform in the former but distinctly alternate in the latter. The difference in the character of plications, however, especially in this case, cannot be regarded as a criterion for specific differentiation as one is a dorsal and the other is a ventral valve, and, as such, the plications may not be similar, a feature not uncommonly seen in the opposite valves of certain other strophomenid shells. The Marshbrook specimen is of Caradocian time, which is approximately equivalent to Richmond of North America.

Remarks.—This species is represented by a single individual showing the exterior of a dorsal valve. Its distinctiveness and its striking similarity to Troedsson's "*Strophomena fluctuosa*," which he believes to represent the Richmond portion of the Cape Calhoun beds at Cape Calhoun, Greenland, suggest the possibility that it may become a good horizon marker.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28273.

Strophomena sp. I

Description.—Shell (dorsal valve) of medium size, length 16 mm., width 22 mm., widest at the hinge line. Sub-semielliptical in outline. Flat or slightly convex at the umbonal region, the convexity increasing evenly toward the central and anterior regions, from which the surface rounds off abruptly to the front and lateral margins. Hinge line straight; cardinal extremities acute, a little compressed and deflected. Beak small, indistinct.

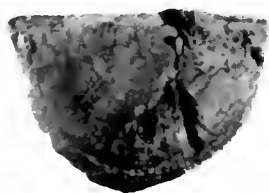


FIG. 64. *Strophomena* sp. I. F.M. No. P28274. Dorsal valve; $\times 1\frac{1}{3}$.

Surface ornamented with alternating plications, the stronger ones increasing by implantation near the front and lateral margins, the finer ones crowded, becoming totally undefined anterior to the umbonal region. Concentric wrinkles faint and few.

Remarks.—The diagnostic characters of this form, which is known only from a single dorsal valve, are insufficiently clear to permit its reference to any described species.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Strophomena sp. II

Remarks.—This form is represented by a very poorly preserved ventral valve, which is strongly depressed at the umbonal region. The surface is marked by subrounded, not quite straight, alternating plications in groups of four or five. These are all crossed by numerous closely spaced concentric lines of growth, giving the surface a roughened appearance. In its present state of preservation it cannot be compared with any known species nor does it allow any adequate description. It has, however, the main characteristics of the genus *Strophomena*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

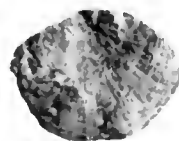


FIG. 65. *Strophomena* sp. II. F.M. No. P28275. Ventral valve; $\times 1\frac{1}{3}$.

Order **Telotremata** Beecher
 Superfamily **Rhynchonellacea** Schuchert
 Family **Rhynchonellidae** Gray
 Subfamily **Rhynchotreminae** Schuchert
 Genus **Rhynchotrema** Hall

Rhynchotrema capax arcticum Roy, var. nov.

Diagnosis.—This variety, represented by a young, well-preserved specimen, is closely allied to *Rhynchotrema capax* (Conrad), but only to those forms that are obese, gibbous, and have very strongly convex valves. It is well known that various specimens of *Rhynchotrema*, occurring in the Richmond, though obviously not conspecific, have been identified as *Rhynchotrema capax* merely



FIG. 66. *Rhynchotrema capax arcticum* Roy, var. nov. F.M. No. P28277. Holotype. *a, b, c*, Ventral, dorsal, and lateral views, respectively; $\times 1\frac{1}{2}$.

because of a superficial resemblance to that species and more particularly because they were found in the Richmond. As such, a reference is here made to that form of *R. capax* to which the present variety is allied. The obese type originally described by Conrad (Jour. Acad. Nat. Sci. Phila., 8, p. 264, pl. 14, fig. 21, 1842) is abundant in the Whitewater in Indiana and Ohio and other localities.

This arctic variety is also obese and gibbous and has strongly convex valves, but relative to its size and age these features are much more accentuated than in *R. capax*. Furthermore, the concentric lines of growth of the present variety are much more densely set. These growth lines, due to extensive exfoliation of the conchioline layer, can only be seen on a small area on the left antero-lateral side of the shell.

The Cape Calhoun specimens described and figured by Troedsson (1928, p. 94, pl. 23, figs. 6–8) as *R. capax* probably belong to this variety. His specimens, like the Silliman's Fossil Mount one, are also gibbous and strongly convex, with the characteristic densely set growth lines.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Ralph Robinson.

Holotype.—F.M. No. P28277.

Rhynchotrema anticostiense breve Roy, var. nov.

Description.—Shell very small, wider than long, length 7.5 mm., width 7.8 mm., subtriangular in outline. Ventral valve moderately convex. Median

sulcus with three plications begins shallow a little below the beak and rapidly deepens and widens anteriorly. Beak much elevated and slightly incurved. Cardinal area short but high.

Dorsal valve convex, strongest at the umbonal region, sloping moderately in all directions. Beak pointed, slightly incurved, and situated well below the beak of the ventral valve. Median fold with four plications hardly recognizable posteriorly, but becoming deep and well defined anteriorly.

Surface of both valves marked by 22 radiating plications which appear simple under an ordinary hand lens but under high power they show distinct



FIG. 67. *Rhynchotrema anticostiense breve* Roy, var. nov. F.M. No. P28278. Holo-type. *a, b*, Ventral and dorsal views, respectively; $\times 3$.

signs of bifurcation, particularly on the posterior portions. The bifurcating lines are very shallow and being on the rounded surface they are not clearly visible unless oriented in the position of maximum illumination. Near the front and lateral margins where the conchioline layer is preserved the plications are crossed by concentric imbricating lamellae.

Diagnosis.—This variety very closely resembles *Rhynchotrema anticostiense* (Billings), particularly in its general outline, beak, fold, and sulcus. It is, however, a smaller form and, relative to its size, it has a greater number of plications. Its dorsal valve is also not so gibbous, being less elevated at the umbonal region and flatter at the front. These differences, however, although apparent, are not as striking as the similarities referred to above. It has thus been considered more appropriate to make a varietal than a specific differentiation.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28278.

Rhynchotrema sp.

Description.—Small, transversely suboval; wider than long; width 11 mm., length 9.5 mm.

Ventral valve convex in the umbonal region, sloping abruptly laterally. Mesial sinus with four plications originates at a short distance from the umbo and widens rapidly anteriorly. Beak partially broken, preserved portion elevated and slightly incurved over that of the opposite valve.

Only the posterior half of the dorsal valve is preserved. This is gibbous in the middle, sloping gradually to the postero-lateral margins. There is no trace

of a median fold at or near the preserved portion. If there were any in the anterior part, it cannot be seen in the present state of the specimen.

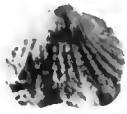


FIG. 68. *Rhynchotrema* sp. F.M. No. P28279. Ventral view; $\times 1\frac{1}{3}$.

Remarks.—Only a single specimen of this species was collected. It is somewhat crushed, especially the dorsal valve, and does not allow much closer identification or a more satisfactory description. It coincides more nearly with the description of *Rhynchotrema increbescens* (Hall) than any other described species of the genus, but it is much wider in outline, somewhat resembling *R. increbescens laticostatum* (Winchell and Schuchert).

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Superfamily **Spiriferacea** Waagen

Family **Atrypidae** Gill

Subfamily **Zygospirinae** Waagen

Genus **Zygospira** Hall

Zygospira maynei Roy, sp. nov.

Description.—Longitudinally subovate, narrowed toward the beak; very small; length and width almost equal, the largest (holotype) 5 mm. long and 4.9 mm. wide.

Ventral valve convex, greatest convexity at the umbonal region. Beak extended, slightly incurved and defined on each side by a curved ridge, originating

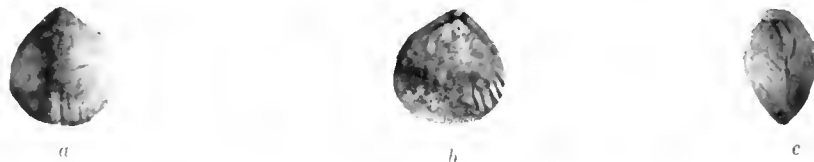


FIG. 69. *Zygospira maynei* Roy, sp. nov. F.M. No. P28280. Holotype. *a*, *b*, *c*, Ventral, dorsal, and lateral views, respectively; $\times 4$.

at the beak and terminating about mid-length on the lateral margin. Median sulcus, with one or two plications, commencing below the umbo and extending to the front.

Dorsal valve much less convex than the ventral, most elevated at the umbo, thence sloping abruptly to the front margin. A rudimentary fold consisting of three plications begins in an undefined manner posterior to the middle, widening gradually towards the front. This valve is also characterized by having a depressed area on each side of the beak directly opposite the curved ridge of the ventral valve.

Surface ornamented with faint but coarse, round plications, which appear simple, but when examined under a microscope they show distinct signs of bifurcation.

Diagnosis.—This species is more closely related to *Zygospira recurvirostris* (Hall) than any other known species of the genus. It is, however, a smaller form with a less gibbous dorsal valve and fewer plications. Its anterior portion is also narrower. The young forms of this species are usually flatter and wider, roughly resembling *Zygospira modesta* Hall. The general outline of the anterior portion and the manner of the plications are *Zygospira*-like, but the posterior half reminds one of the genus *Cyclospira*. The structure of the interior is unknown and there are no specimens at hand suitable for sectioning.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Sharat K. Roy, Ralph Robinson, and John Jaynes.

Holotype.—F.M. No. P28280.

Family Cyclospiridae Schuchert

Genus Cyclospira Hall and Clarke

Cyclospira schucherti Roy, sp. nov.

Description.—Shell subtrihedral, small, slightly longer than wide, the holotype being 13 mm. long and 12 mm. wide.

Ventral valve strongly convex, beak incurved, prominent, projecting over the hinge. Median sulcus in reality a partly furrowed ridge, the furrow beginning near the umbo at about one-third the length of the valve and widening rapidly anteriorly. This furrowing of the ridge makes two narrow keels, one on each side of the median sulcus. The unfurrowed posterior part of the ridge gives the umbo a prominent appearance. Lateral slopes abrupt, interrupted only in the umbo-lateral regions by a short fold on each side. These folds originate at the beak and lie just within the margins.

Dorsal valve depressed-convex, prominent on the umbonal region. Beak very small, concealed in most specimens by the incurved, projecting beak of the opposite valve. Median sulcus bears a low fold between two well-defined grooves, but in most adult specimens the fold is bifurcated by a narrow groove, which begins at the beak and extends to the front margin. The front, therefore, has three grooves, two on the lateral sides of the fold and one on the middle, thus making the front trisulcate. The bifurcating groove of the fold is present in every specimen examined, but in some cases the groove dies out before reaching the front margin. In such examples, the front has a bisulcate appearance.

Surface of the shell is marked by delicate growth lines and in perfectly preserved adult specimens by a few short, faint but wide plications along the antero-lateral margins. Two or three of the plications bordering the keels of the median sulcus of the ventral valve are longer than the others, but none extends posterior to the middle.

Several vertical and lateral sections (fig. 70, *e*, *f*) of specimens possessing largely translucent fillings (crystalline calcite) have been made, but none gives the desired information regarding the brachidium. This is largely because every specimen that was sectioned (seven in all) had some opaque portions in it; that is, had portions that were filled with calcareous mud and organic matter.

The dorsal hinge in one of the sections appears to be a short, slightly arched plate upon which rest the crura, which have the shape of that of an axial section

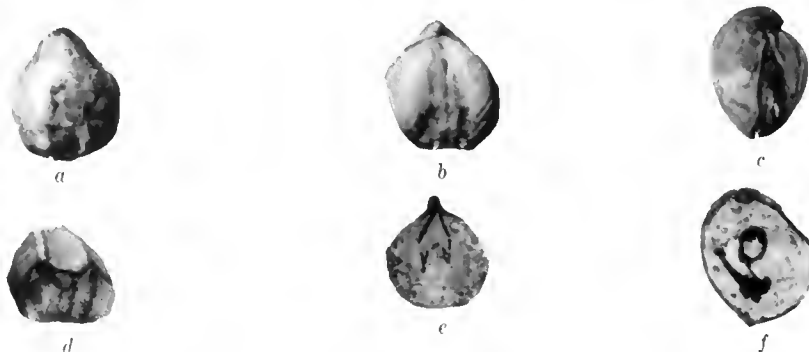


FIG. 70. *Cyclospira schucherti* Roy, sp. nov. F.M. No. P28282. Holotype. *a*, *b*, *c*, *d*, Ventral, dorsal, frontal, and lateral views, respectively. *e*, Vertical section. *f*, Lateral section. All $\times 2$.

cut through the curved surface of a truncated cone. Directly below what are presumably the points of union between the crura and primary lamellae, the ribbons diverge a little laterally. Thence they follow the inner surface of the inside borders of the sinus of the dorsal valve, curve upward, following the contour of the inner surface of the keels of the ventral valve, and terminate in two and one-half(?) volutions. The spiralia are slightly introverted and nearly parallel to the vertical axial plane of the shell.

The above description of the brachidium, with the exception of the structure of the crura and their relation to each other, roughly agrees with Hall's figure of the brachidium of *Cyclospira bisulcata* (Emmons) in lateral section (Hall and Clarke, 1893, text fig. 136), but it does not completely conform to his figure of the vertical section (op. cit., text fig. 135). The brachidium of *Cyclospira bisulcata*, from Cannon Falls, Minnesota, described and figured by Winchell and Schuchert (1893, p. 471, pl. 34, fig. 54) is also substantially different from either the figures and description of Hall and Clarke or what has been observed during the present study. It is obvious, therefore, that the brachidium in question has not yet been satisfactorily studied by any investigator and it would be premature to discuss its structure at this time. Serial sections of specimens composed wholly of crystalline calcite seem to be the only means by which the true nature of the brachidium may be known. Such specimens, however, are not abundant.

Diagnosis.—That the present species is closely related to *Cyclospira bisulcata* (Emmons) seems apparent. However, so far as it could be judged from external

characters, its relationship to *C. bisulcata* from Cannon Falls, Minnesota, is more pronounced than to that same species from Adams, Jefferson County, New York. In fact, it is doubtful if the species *C. bisulcata* from Minnesota is the same as the one from New York. Externally they are not identical, and their internal characters (brachidia), as referred to above, show even greater differences. Furthermore, it is pertinent to mention that *Camarella owatonnensis* (Sardeson) from Owatonna, Minnesota, which is regarded as a synonym of *Cyclospira bisulcata*, may also be a distinct species. Specimens of *C. bisulcata* from Cannon Falls, Minnesota, do not agree with either Sardeson's description of *Camarella owatonnensis* or his figures (Sardeson, 1891-92, p. 328, pl. 4, figs. 1-3). Likewise, *Rhynchonella bisulcata* (Safford), which has also been regarded as a synonym of *C. bisulcata* and of which Safford gives two figures (Safford, 1869, p. 275, figs. 7, 14) is in all probability a distinct species. It may not even be a *Cyclospira*. That there exists some confusion among the synonyms of *C. bisulcata* is quite evident and it is desirable that a revision be made of this species. Until this revision is accomplished, little or nothing can be done except to regard *C. bisulcata* and its synonyms as one species. In this paper, the arctic species has been compared only with *C. bisulcata* from New York and Minnesota, and although its affinity with either form cannot be overlooked, it can be separated from both by the following distinguishing characters: Sulcus in the ventral valve broader; beak in profile more flattened; sulcus in the dorsal valve originating nearer to the beak; dorsal valve flatter; and beak ridge more pronounced.

Remarks.—The specific name is in honor of Professor Charles Schuchert, of Yale University.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Sharat K. Roy, John Jaynes, and Ralph Robinson.

Holotype.—F.M. No. P28282.

Cyclospira vokesi Roy, sp. nov.

Diagnosis.—This species is similar in general aspect to *Cyclospira schucherti* Roy. Therefore a formal description does not seem necessary. It is,

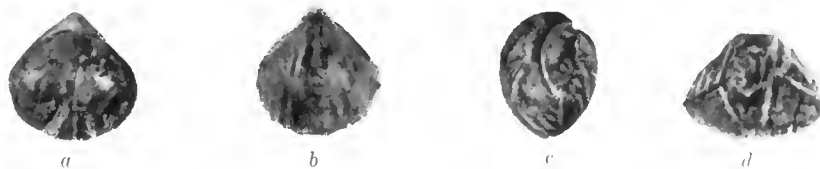


FIG. 71. *Cyclospira vokesi* Roy, sp. nov. A.M.N.H. No. 4803. Holotype. *a*, *b*, *c*, *d*, Ventral, dorsal, frontal, and lateral views, respectively; $\times 2\frac{1}{3}$.

however, relatively shorter, wider, and thicker. Its chief distinguishing feature is its surface markings, consisting of three wide but shallow ribs on either side of the ventral and dorsal sulci. The ribs are moderately prominent on the anterior portion but become obscure posteriorly.

Remarks.—Three specimens have been observed, two in the Field Museum collection and the third in the American Museum of Natural History (A.M.N.H. No. 4803), upon which the species is based. The two Field Museum specimens were securely embedded in the matrix and were badly damaged while being freed. The American Museum specimen (holotype) is 6 mm. long, 7 mm. wide, and 5 mm. in maximum convexity.

The specific name is in honor of Dr. H. E. Vokes, of the American Museum of Natural History.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—The specimen in the American Museum was collected by R. W. Porter, the Field Museum specimens were collected by Sharat K. Roy.

Holotype.—A.M.N.H. No. 4803.

Phylum MOLLUSCA

Class Pelecypoda Goldfuss

Pelecypods are very poorly represented in the collection. This, however, does not indicate that they are rare at the head of Frobisher Bay, for Schuchert (1900, pp. 160–163) has described from this locality about two dozen specimens representing seven genera and twelve species. His material, moreover, was collected in a few hours' time. It seems, therefore, that the pelecypods are more or less localized in the formation, or at least are not as uniformly distributed as are the representatives of the other classes. This restricted occurrence may be due to facies factors. All the pelecypods collected are thin-shelled. Existing thin-shelled northern genera such as *Nucula*, *Yoldia*, and *Leda* inhabit quiet waters with clayey or fine sandy bottoms. The adhering clayey matrix (see analysis of Bed C, p. 43) of nearly every Frobisher Bay pelecypod observed in either Schuchert's or the present collection, therefore, strongly suggests that at one or more times during the deposition of the beds the limey facies unfavorable to pelecypods gave place to a clayey or fine sandy facies favorable to them.

Collections made at various other arctic Ordovician localities, such as Akpatok Island in Hudson Strait, Putnam Highland in Baffin Land, and Cape Calhoun in Greenland, contain few or no pelecypods. It is possible that at these places, clayey facies either did not occur or, if present, have not been worked extensively.

Order Prionodesmacea Dall

Superfamily Nuculacea Dall

Family Ctenodontidae Dall

Genus *Ctenodonta* Salter

Ctenodonta baffinensis Ulrich

Ctenodonta baffinensis Ulrich, Proc. U. S. Nat. Mus., **22**, p. 161, pl. 13, figs. 7–10, 1900.

Remarks.—There are two casts of this little shell. Both appear identical in all important characters with *C. baffinensis* Ulrich, except that they are

distinctly smaller and the median sulcus which extends vertically from the beaks across the valves is not quite so strong. These minor differences are probably due to the fact that the Field Museum specimens are younger examples.

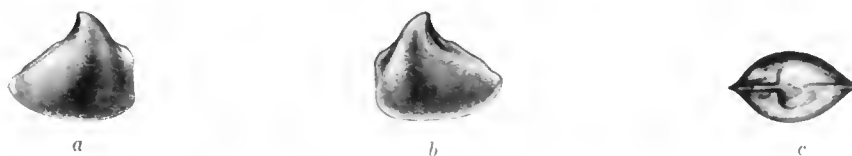


FIG. 72. *Ctenodonta baffinensis* Ulrich. F.M. No. P28285. Three views of a cast of the interior. *a*, Right valve. *b*, Left valve. *c*, Cardinal view. All $\times 2$.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Ctenodonta cf. *C. subnasuta* Ulrich

Cf. *Ctenodonta subnasuta* Ulrich, Geol. and Nat. Hist. Surv. Minn., 3, pt. 2, p. 585, pl. 42, figs. 34-36, 1894.

Remarks.—This form resembles *C. subnasuta* Ulrich, and may belong to that species. The shell, however, is too poorly preserved for a satisfactory comparison. The posterior end is broken and the surface characters are largely obscured by calcareous incrustation.

C. subnasuta is a widely distributed species, having been reported from the Black River and the Trenton of various localities in the United States and Canada. Typical *C. subnasuta* is believed to occur in the Trenton of Manitoba but whether the horizon is Trenton or younger remains a disputed question. *C. subnasuta* Ulrich(?) has also been reported from the head of Frobisher Bay, Baffin Land, by Schuchert (1900, p. 160, pl. 13, figs. 4-6). Schuchert's specimens¹ have been examined; apparently they are more closely related to *C. ulrichi* Roy, described below, than to *C. subnasuta*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Ctenodonta ulrichi Roy, sp. nov.

Description.—Shell small, transversely elongate, subovate, the length (16 mm.) a little less than twice the height (10 mm.); greatest thickness (below the umbones), 6.5 mm. Anterior end about two-fifths of the entire length, broadly and regularly rounded at the extremity; posterior end tapering, narrowing to a

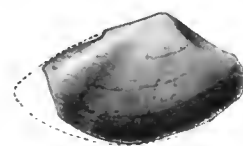


FIG. 73. *Ctenodonta* cf. *C. subnasuta* Ulrich. F.M. No. P28286. Right valve of a cast of the interior; $\times 2$.

¹ Two casts of the interior, one complete, the other broken at the posterior end. The complete one is larger. U.S.N.M. No. 28163.

rather acutely rounded extremity. Dorsal outline biconcave, the anterior portion the deeper; ventral outline gently convex in the posterior half but curving strongly upward in the anterior shelf. Beaks small but high and prominent, incurved, widely separated, situated about two-fifths of the entire length from the anterior extremity and turned toward the anterior end. Umbones high, distinctly convex, the convexity passing in ventral direction into a low and gradually widening fold that reaches the middle of the ventral edge and causes a slight protrusion. This fold is flanked on either side by gently diverging, very weak

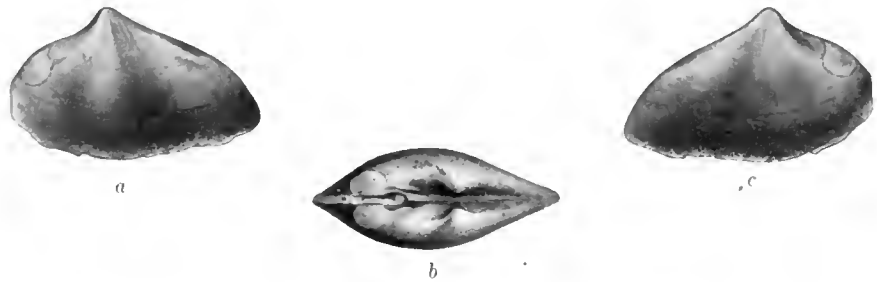


FIG. 74. *Ctenodonta ulrichi* Roy, sp. nov. F.M. No. P28287. Holotype. Three views of a cast of the interior. *a*, Left valve. *b*, Cardinal view. *c*, Right valve. All $\times 2$.

lines. Anterior and posterior cardinal slopes marked by low umbonal ridges, the anterior ridges being the more sharply defined. Impressions of adductor muscles shallow but clearly outlined, the anterior pair larger and more rounded than the posterior pair.

Judging from the high and prominent beaks it is apparent that the hinge plate was broad and strong. Imprints of the inner ends of the denticles ($6\pm$) in the hollow resulting from the solution and removal of the hinge plate can be seen under the hand lens. Though only a few of these imprints are preserved, they clearly establish the generic relations of this specimen. The surface, in addition to having the characters referred to above, is marked by obscure concentric lines.

Diagnosis.—In general aspect, particularly as to its form, this species is reminiscent of *Ctenodonta subnasuta* Ulrich and *Ctenodonta cuneiformis* Ulrich, but it seems to be closest to the larger of the two specimens (U.S.N.M. No. 28163; see footnote on p. 107 of this paper) which Schuchert has doubtfully referred to *Ctenodonta subnasuta* Ulrich(?). The present species, however, differs from the specimen in the United States National Museum in having fuller and more prominent umbones, more incurved and widely separated beaks, and a much stronger hinge plate. It also differs in the character of its surface folds and furrows.

Remarks.—The test of this species was apparently thin, as evidenced by the presence of some well-defined impressions of exterior markings.

The specific name is in honor of Dr. E. O. Ulrich, of the United States National Museum.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28287.

Class **Gastropoda**

The gastropods, particularly those representing *Maclurina* and *Maclurites*, are quite common in Silliman's Fossil Mount. Unfortunately, however, they are preserved mostly as casts of the interior. The test, with negligible exception, is missing, and hence, surface characters which furnish reliable data for specific determinations are also wanting. Identifications of gastropods from such meager diagnostic characters as are afforded by casts are uncertain.

Although these casts are common and numerically rank highest next to the brachiopods, only sixteen species referable to eight genera and four families are represented in this collection. Of these, three are new, and six are either conspecific with described species or closely related to them. The remaining seven are too imperfect for certain identification.

It may be of interest to mention here that several specimens belonging to the genera *Maclurina* and *Maclurites* were collected *in situ* from the uppermost bed of the mount. The only other specimen that was collected *in situ* is a cephalopod, *Westenoceras greggi* Roy (p. 141).

Subclass **Streptoneura** Spengel

Order **Aspidobranchia** Schweigger

Suborder **Rhipidoglossa** Troschel

Family **Pleurotomariidae** d'Orbigny

Genus **Lophospira** Whitfield

Lophospira cf. **L. augustina minnesotensis** Ulrich and Scofield

Description.—Height as preserved, 132 mm.; greatest diameter 76 mm.; apical angle 35; consisting of at least seven whorls of which the upper three and part of the apertural whorl are missing. Whorls strongly convex; upper slope angular; peripheral band obscurely outlined and situated about two-thirds of the way down the whorls; portion below the band abruptly rounded or obtusely angulated. Umbilicus large, relative to the height of the shell, umbilical cavity extending throughout. Test, judging from the portions attached to the specimen, thick, particularly in sutural parts; no external markings preserved on the attached test.

Remarks.—In general form, in the position of its peripheral band, and in the angulation of its whorls, the present cast more closely resembles the variety *Lophospira augustina minnesotensis* Ulrich and Scofield than the species. It is, however, not sufficiently well preserved for detailed comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.



FIG. 75. *Lophospira* cf. *L. augustina minnesotensis* Ulrich and Scofield. F.M. No. P28839. A fairly complete cast of the interior; natural size.

***Lophospira* sp. I**

Remarks.—Beyond the fact that this cast, consisting of less than two whorls (the last and a broken one above), is a *Lophospira*, no other definite information concerning it can be given.



FIG. 76. *Lophospira* sp. I. F.M. No. P28840. A fragmentary cast of the interior; natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

Lophospira sp. II

Remarks.—Only the last two whorls of this form are preserved. It is larger and flatter than the preceding one and probably belongs to a different species. The flatness, however, may be the result of pressure of the overlying beds. In any case, the specimen is not sufficiently complete for accurate comparison.



FIG. 77. *Lophospira* sp. II. F.M. No. P28841. An incomplete cast of the interior; natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Hormotoma* Salter

Hormotoma rotundivolvis Roy, sp. nov.

This species is represented by a single, fairly complete specimen.

Description.—Height (as far as preserved) 120 mm.; greatest diameter 60 mm.; apical angle about 30; composed of at least eight more or less uniformly convex whorls, of which the last five are present. Suture deep. Band (barely visible) submedian. Umbilicus small.

Diagnosis.—Of the species compared *Hormotoma*(?) *major* (Hall) seems to be the only one to which the present species is very closely allied. It can, however, be distinguished by its slender shape and by the sudden decrease in size of its third whorl from below. Its whorls are also more rounded, approaching those of *Hormotoma trentonensis* Ulrich and Scofield.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

Holotype.—F.M. No. P28842.



FIG. 78. *Hormotoma rotundivolis* Roy, sp. nov. F.M. No. P28842. Holotype. A cast of the interior; natural size.

Hormotoma spp. I, II, and III

Remarks.—Several specimens of small *Hormotomas* representing at least three different species are in the collection. None of these specimens, however, is sufficiently complete for specific determination.

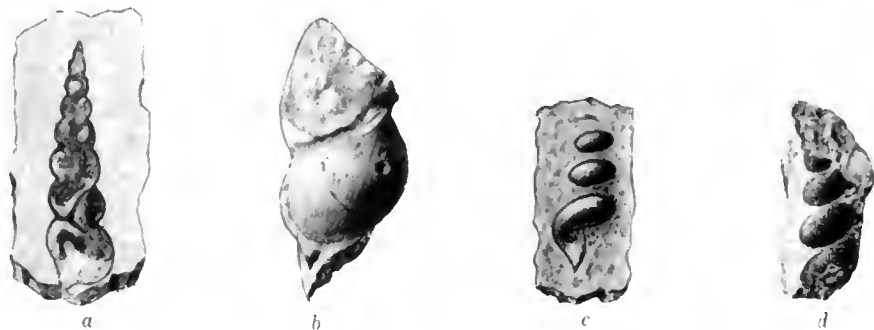


FIG. 79. *a*, *Hormotoma* sp. I. F.M. No. P28843. A fairly complete vertical section; $\times 2$. *b*, *Hormotoma* sp. II. F.M. No. P28844. A fragmentary cast; natural size. *c*, *d*, *Hormotoma* sp. III. F.M. No. P28845. Both incomplete casts; natural size.

Hormotoma sp. I: Shell slender, very small; height 12 mm.; greatest diameter 3.5 mm.; apical angle about 15; composed of eight nearly uniformly rounded volutions.

This form appears allied to *Hormotoma gracilis* cf. var. *augustata* (Hall) from the Black River.

Hormotoma sp. II: The preserved portion of this form somewhat resembles the Trenton species *Hormotoma salteri* Ulrich.

Hormotoma sp. III: This form is represented by two specimens but neither has retained any diagnostic character for specific identification.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Eotomaria* Ulrich and Scofield

Eotomaria(?) *robinsoni* Roy, sp. nov.

Clathrospira conica (in part) Schuchert, Proc. U. S. Nat. Mus., 22, p. 65, 1900.

Description.—Shell conical, with moderately rounded base, short-spined, consisting of four and one-half complete whorls, probably one additional whorl

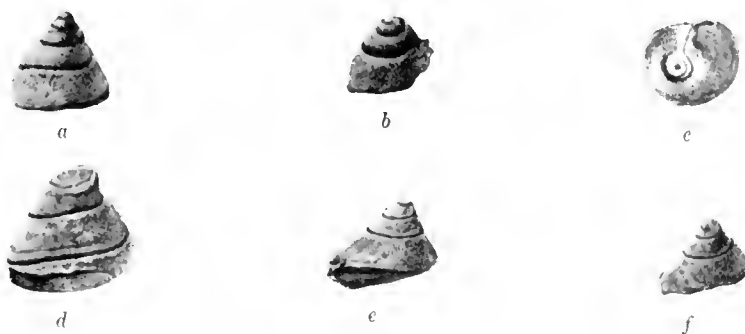


FIG. 80. *Eotomaria*(?) *robinsoni* Roy, sp. nov. *a*, F.M. No. P28846; holotype. *b, c, d, e, f*, F.M. No. P28846A; paratypes.¹ All are internal casts showing different views; $\times 1\frac{1}{2}$.

and initial bulb missing. Greatest width and height about equal, varying between 7 and 9 mm. Apical angle 68 to 75. Upper surface of the last whorl sloping, nearly flat; that of the preceding whorls convex or gently rounded. Suture sharply impressed but shallow. Band not clearly defined, rather broad, concave, nearly vertical, situated above the periphery of the last whorl and immediately above the suture line on the preceding whorls. Umbilicus small, partly obscured by what appears to be a reflexed inner lip. Aperture rhomboidal in cross section, its margins and growth lines on the surface not preserved, thus making it impossible to determine whether the peripheral band is terminated by a notch or a slit.

Diagnosis.—In the absence of essential diagnostic characters, the generic position of this species will necessarily remain uncertain. In general shape, in

¹ A sixth paratype, F.M. No. P28846A, is in the collection but not figured here.

size, and in the contour of the surface of the slopes of its whorls it somewhat resembles *Clathrospira conica* Ulrich. It cannot, however, be referred to *Clathrospira*, for that genus is characterized by having the band directly upon the periphery instead of upon its apical side, as in the case of the present species. Of the half dozen or so of the described species of *Eotomaria*, to which this arctic species has been doubtfully referred, only one species, *E. canalifera* Ulrich, has some general resemblance to *Eotomaria(?) robinsoni* Roy. *E. canalifera*, however, has a wider apical angle, is broader than high in lateral view, and the surface of the slopes of the whorls is decidedly concave.

Dr. E. O. Ulrich, who has examined these arctic gastropods, is inclined to regard them as related to certain Gotland shells, particularly to the two species described by Lindström (1884, p. 150, pl. 14, figs. 18–21 and 35–43) as *Trochus dali* and *T. wisbyensis*. It is not certain whether the "band" in *E. robinsoni* is a true pleurotomarian band or whether its margins correspond to the longitudinal ridges seen in Lindström's species. This is a point which cannot be decided without a specimen that has retained the growth lines or the mouth itself.

Remarks.—The United States National Museum has six specimens (U.S.N.M. No. 28178) collected by J. N. Carpender, A. V. Shaw, and A. H. White from Silliman's Fossil Mount, Frobisher Bay, Baffin Land, and identified by Schuchert as *Clathrospira conica*. The smaller three of these six specimens are identical with *E. robinsoni* and represent the same species. The larger three are probably *C. conica*.

The specific name is in honor of Mr. Ralph Robinson of Worcester, Massachusetts, who acted as mate of the Expedition Schooner *Bowdoin* and from whom was received invaluable aid in the field.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Ralph Robinson, John Jaynes, and Sharat K. Roy.

Holotype.—F.M. No. P28846.

Family **Euomphalidae** de Koninck

NOTES ON INTERNAL CASTS OF MACLURINA AND MACLURITES

The great majority of species belonging to the genera *Maclurina* and *Maclurites* have been founded on casts of the interior without the opercula. As such, the generic reference as well as the validity of a number of described species of these two genera remains questionable. Casts of the interior are extremely deceiving even to the most discerning eyes. The inner whorls in a cast appear higher than the last whorl, whereas in the original they might actually have been on a level with it or even lower, for the thickness of the test increases with each succeeding whorl and with age. Likewise, the suture in the cast may appear wider than its actual width, depending on the original thickness of the test. Further, inasmuch as the width of the suture may vary considerably in the same species, it cannot always be used as a dependable specific character. It is also apparent that a large number of the casts have been deformed by pressure

and by weathering, adding to the difficulties of satisfactory comparison with allied forms. These are important reasons why, when dealing with casts, more than ordinary caution must be exercised if confusion is to be eliminated and the species properly established. Experience shows that the size and nature of the umbilicus and the rate and manner of the growth of the whorls, all of which are best seen in vertical sections through the center, are the more easily recognized and reliable diagnostic criteria for differentiating low or flat spired casts such as these under discussion.

In the collection there are forty-two casts representing the two genera *Maclurites* and *Maclurina*. Employing the above-mentioned procedure, it has been possible to separate the casts into three species. They appear closely related to *Maclurina manitobensis* (Whiteaves), *Maclurina cuneata* (Whitfield), and *Maclurites crassus* (Ulrich and Scofield), but it is not certain that they are conspecific. This is chiefly because it was found impractical to make satisfactory comparisons with published figures.

These casts are here regarded as sinistral, the flat side representing the spire and the umbilicated side the base. This orientation of the maclurid shells is not in accordance with the views held by Ulrich and Scofield. They believed that the shells were dextral and that the flat side was the base and the umbilicated side the spire on the basis that the "ridge which usually surrounds the umbilicus" corresponded to the "notch-keel of the Euomphalidae." (Ulrich and Scofield, 1897, p. 1038.) This is a possible interpretation but not entirely convincing. Living species of many gastropod families, e.g., the Trochidae, Turbinidae, Magilidae, and others, possess umbilical ridges on their bases, and the same might have been true of the shells under consideration.

Genus *Maclurina* Ulrich and Scofield

Maclurina manitobensis(?) (Whiteaves)

Maclurina manitobensis (Whiteaves). Bassler, Bull. U. S. Nat. Mus., **92**, p. 777 (with synonyms), 1915; Troedsson, Medd. om Grønland, **72**, p. 21, pl. 9, fig. 3, pl. 7, fig. 2, 1928; Hussey, Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, p. 73, pl. 3, figs. 1, 5, pl. 4, fig. 4, 1928; Wilson, Trans. Roy. Soc. Canada, **25**, ser. 3, sec. 4, p. 300, pl. 4, fig. 3, 1931; Teichert, Rept. Fifth Thule Exped., 1921-24, Gyldendalske Boghandel, Nord. Forlag, **1**, No. 5, p. 74, pl. 14, fig. 1, pl. 15, fig. 2, 1937.

Remarks.—This well-preserved cast, having a maximum diameter of 116 mm., agrees in all essential particulars with *Maclurina manitobensis* (Whiteaves). The surface ornamentation (growth lines) is also similar, as indicated by a fragment of the test preserving the impression of exterior sculpture. The only noticeable difference is that its basal or umbilicated side is more prominent than observed in the published figures, the specimen at hand approaching in this character the shape of *Maclurina cuneata* (Whitfield).

This widespread Trenton species has also been recorded from the Richmond of Putnam Highland, Baffin Land.



FIG. 81. *Maclurina manitobensis*(?) (Whiteaves). F.M. No. P28847. *a, b, c*, Upper, umbilical, and lateral views, respectively; all natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

***Maclurina cuneata*(?) (Whitfield)**

Maclurina cuneata (Whitfield). Bassler, Bull. U. S. Nat. Mus., **92**, pp. 776-777 (with synonyms), 1915; Hussey, Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, p. 73, pl. 2, fig. 6, pl. 3, fig. 2, pl. 4, fig. 2, 1928.

Original description (Whitfield, 1878, p. 75).—"Shell of medium size, attaining a diameter of three inches [76 mm.] and consisting of two or more volutions, which increase very rapidly in size; lower(?) [upper] side of the shell flat or very

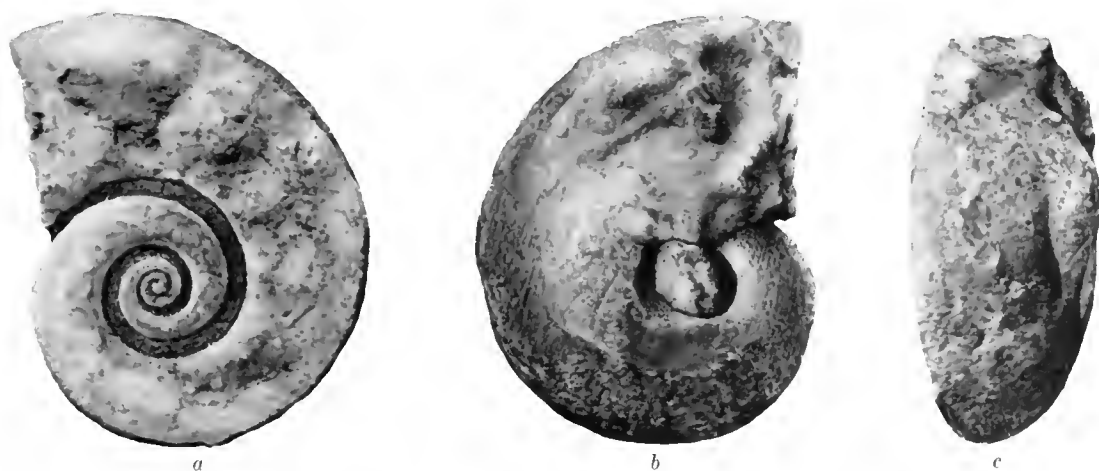


FIG. 82. *Maclurina cuneata*(?) (Whitfield). F.M. No. P28848. *a*, *b*, *c*, Upper, umbilical, and lateral views, respectively; all natural size.

slightly concave between the suture-lines; the opposite side being depressed conical between the outer margin and the central depression, with a very slight convexity of the intermediate surface; outer margin of the volution sharply cuneate; central depression very small in the casts, leaving but little more space than would be occupied by the thickness of the shell. Transverse section of the volution triangular."

Remarks.—Heretofore, so far as known, no specimen of this species has been found to exceed 76 mm. in diameter. In the present collection, however, consisting of twenty-one casts, the largest has a maximum diameter of 133 mm., the smallest 50 mm. All of these casts have the characteristic small umbilicus and regularly sloping under-sides, but variations exist, particularly with regard to the height of the spire, which may be either higher than the last whorl, lower, or on a level with it. Variations have also been observed in the angulation of the outer edges of the whorls, which in some casts are more obtusely angular than in others. These differences, however, are not constant enough to warrant specific or varietal separation.

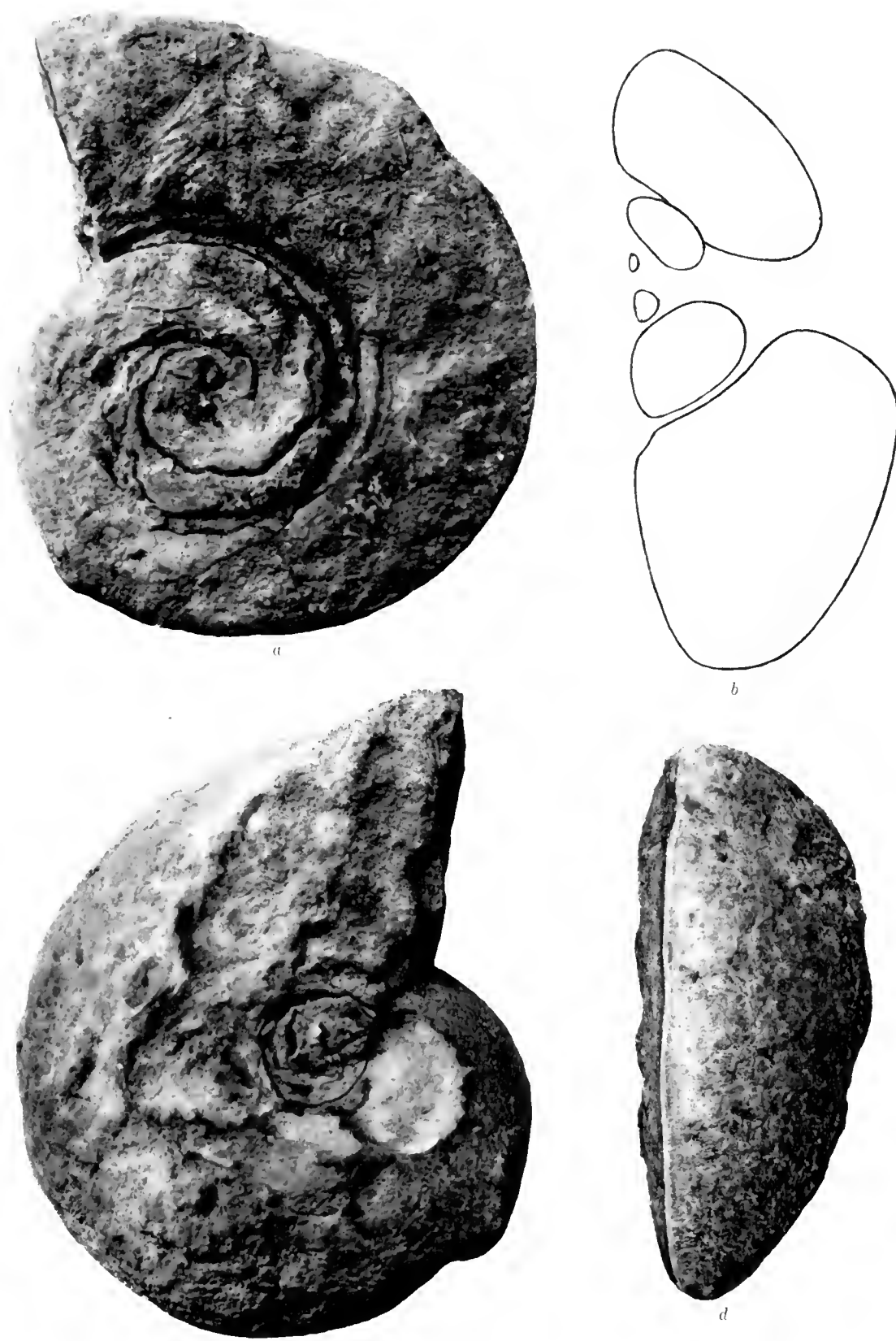


FIG. 83. *Maclurina cuneata*(?) (Whitfield). F.M. No. P28848. a, Upper view. b, Vertical section. c, Umbilical view. d, Lateral view. All natural size.

Maclurina cuneata (Whitfield) occurs in both the Trenton and the Richmond. *Horizon and locality*.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Ralph Robinson, John Jaynes, and Sharat K. Roy.

Genus *Maclurites* Lesueur

The chief difference between the genera *Maclurites* and *Maclurina*, as pointed out by Ulrich and Scofield, is that in the latter the projections for the attachment of muscles on the inner side of the operculum are not present. It is obvious, therefore, that without the operculum generic identification of a maclurid is hardly possible unless it can be shown to be identical with a described species whose operculum is known.

Maclurites crassus(?) (Ulrich and Scofield)

Maclurites crassus (Ulrich and Scofield). Bassler, Bull. U. S. Nat. Mus., **92**, p. 778 (with synonyms), 1915; Troedsson, Medd. om Grønland, **72**, p. 19, pl. 3, fig. 4a-c, pl. 4, fig. 1, 1928; Hussey, Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, pl. 1, figs. 1, 2, pl. 4, fig. 1, 1928; Teichert, Rept. Fifth Thule Exped., 1921-24, Gyldendalske Boghandel, Nord. Forlag, **1**, No. 5, p. 71, pl. 13, figs. 8, 9, 1937.

Remarks.—These casts exhibit variations similar to those just recorded in *Maclurina cuneata* but vertical sections, showing the constancy of specific characters, clearly demonstrate that they represent but one species.

Although *Maclurites crassus* (Ulrich and Scofield) is a common Trenton species, it has also been reported from the Richmond of Putnam Highland, Baffin Land.



FIG. 84. *Maclurites crassus*(?) (Ulrich and Scofield). F.M. No. P28849. *a, b, c*, Upper, umbilical, and lateral views, respectively; all natural size.



FIG. 85. *Maclurites crassus*(?) (Ulrich and Scofield). F.M. No. P28849. *a*, Upper view. *b*, Vertical section. *c*, Umbilical view. *d*, Lateral view. All natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Ralph Robinson, John Jaynes, and Sharat K. Roy.

Maclurites(?) sp.

Remarks.—This form is represented by a single vertical section formed by breaking and natural weathering. It consists of four and one-half whorls, which increase in size rather rapidly. The whorls are coiled nearly in the same plane and hence they are entirely exposed on the umbilical side.

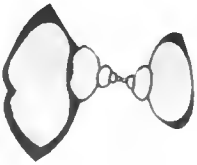


FIG. 86. *Maclurites(?)* sp. F.M. No. P28850. A vertical section; natural size.

The nature of the coiling of the whorls distinguishes this form from any other in the present collection but in the absence of a complete specimen it has not been possible to compare this gastropod with any known species for specific determination.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family **Trochonematidae** Zittel

Genus **Trochonema** Salter

Trochonema cf. **T. umbilicatum** (Hall)

Remarks.—The specimen representing this form agrees in all essential particulars with *Trochonema umbilicatum* and is perhaps conspecific with it. The only difference is that the shoulders of the whorls of the spire are more

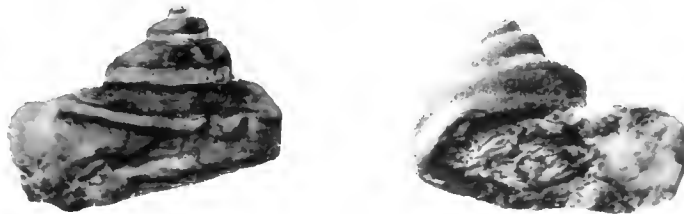


FIG. 87. *Trochonema* cf. *T. umbilicatum* (Hall). F.M. No. P28851. A cast of the interior. Two views of the same individual; natural size.

rounded. In this it resembles *Trochonema beachi* Whitfield. The validity of that species, however, has been questioned by Ulrich and Scofield (1897, p. 1048). Furthermore, the rounding of the shoulders might have been caused by a calcareous deposit, as may be inferred from the difference in the color and texture of the cleaner surface of part of the peripheral regions of the whorls.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Trochonema(?) sp.

Remarks.—This rapidly enlarging, subconical cast, composed of about seven volutions, of which the lower four can be seen, is so badly worn that it is impossible to identify it generically with certainty. It may be a *Lophospira*. The last whorl is large; shoulder slightly concave nearly to the suture; periphery, lower margin of which is obscure, moderately convex; basal portion rounded.

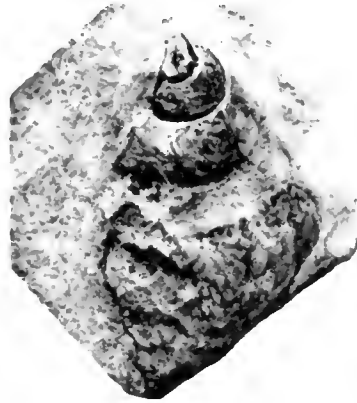


FIG. 88. *Trochonema(?)* sp. F.M. No. P28852. An imperfect cast of the interior; natural size.

These are the only features worth mentioning here, and they do not supply definite diagnostic evidence. In general shape the present form is reminiscent of *Trochonema rectangulare* Raymond from the Chazy of Valcour Island, New York.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Holopea* (Hall)***Holopea(?)* sp.**

Description.—Shell very small, less than 10 mm. in diameter, with three or three and one-half rapidly enlarging volutions, coiling nearly in the same plane so that the inner whorls rise but little above the upper surface of the last. The surface of the specimen is encrusted, but, as far as can be ascertained, the upper side of the last whorl which is not complete is nearly flat; periphery convex, lower side abruptly rounded.

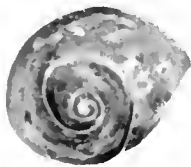


FIG. 89. *Holopea(?)* sp. F.M. No. P28853. A broken interior cast; $\times 3$.

Remarks.—The generic characters of this gastropod are not clear but they suggest the genus *Holopea*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Subclass **Euthyneura** Spengel
 Order **Opisthobranchia** Milne-Edwards
 Suborder **Pteropoda** Cuvier
 Family **Hyolithidae** Nicholson
 Genus **Hyolithes** Eichwald

Hyolithes crowelli Roy, sp. nov.

Description.—Shell of medium size; length as far as preserved 13.5 mm.; maximum width 7.8 mm.; triangularly pyramidal; gradually tapering. Trans-

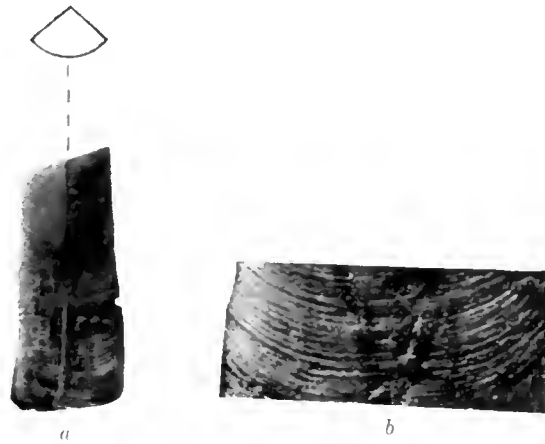


FIG. 90. *Hyolithes crowelli* Roy, sp. nov. F.M. No. P28854. Holotype. *a*, An incomplete specimen, showing flattened side (ventral); $\times 2\frac{1}{2}$. *b*, Enlarged transverse growth lines. *c*, Cross section.

verse section subtriangular. Convex side (dorsal) roof-shaped with angular crest; flattened side (ventral) gently convex; surface of the flattened side marked by very fine closely set transverse growth lines, which curve forward. These lines are not all of equal size. A few are stronger but their distribution shows no definite order.

Diagnosis.—This species is unlike any hitherto described and can be immediately distinguished by its less elevated dorsal side (the angle at the crest being larger), and by its less rapid rate of tapering.

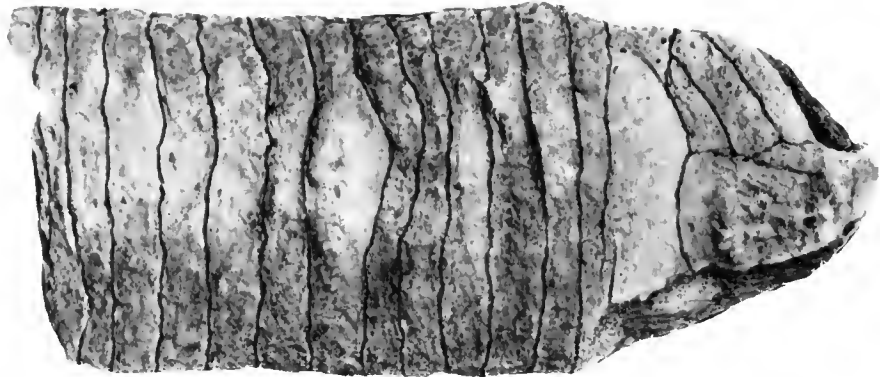
Remarks.—The basal and the apical portions of the specimen are missing. It is also embedded, showing only the ventral side. The outline of the cross section where the apical portion is broken off is, however, sufficiently clear for the determination of the form of the dorsal side.

The specific name is in honor of Captain J. T. Crowell, of Burnt Island, Maine.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

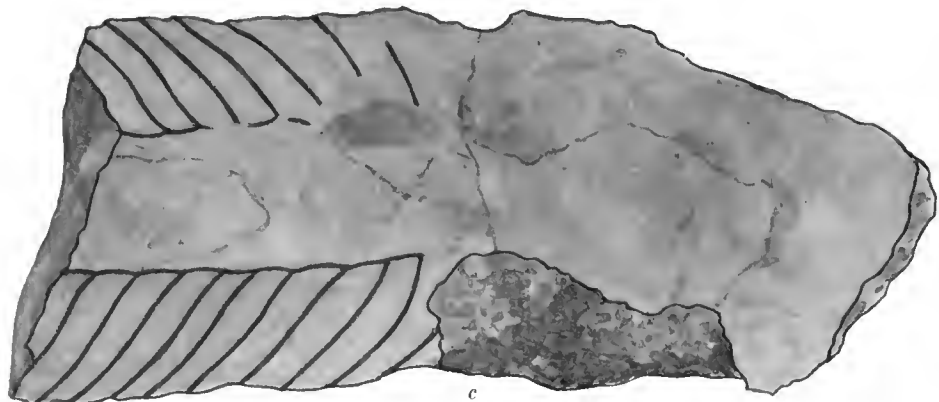
Holotype.—F.M. No. P28854.



a



b



c

FIG. 91. *Endoceras baffinense* Foerste. F.M. No. P28855. a, Dorsal view. b, Left lateral side. c, Ventral side (polished), showing siphuncle. All natural size.

Class Cephalopoda

Cephalopods are comparatively common at the head of Frobisher Bay, Baffin Land. In the present collection there are twenty-two specimens, representing eleven genera and twenty species. The specimens are all casts of the interior, and unfortunately none is complete. In the majority of cases, however, a sufficient portion of the conch was preserved for dorso-ventral sectioning. It was, therefore, possible to examine the structure of the siphuncle in almost every specimen which required such an examination for generic identification.

For stratigraphic reasons, it may be of interest to mention that, of the cephalopods described here, only one, *Westenoceras greggi* Roy, sp. nov., was found *in situ*,¹ all the others having been collected from the loose material on the slopes of the outcrop.

Subclass Tetrabranchiata Owen

Order Nautiloidea Zittel

Suborder Holochoanites Hyatt

Family Endoceratidae Hyatt

Genus Endoceras Hall

Endoceras baffinense Foerste

Cameroceras proteiforme Schuchert, Proc. U. S. Nat. Mus., 22, p. 169, 1900.

Endoceras baffinense Foerste, Bull. Sci. Lab. Denison Univ., 23, pp. 14-15, pl. 7, fig. 5, 1928.

Remarks.—A single internal cast representing this species was collected. It is like the holotype in general outline, length of the camerae, and structure of the siphuncle.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Endoceras sp. I

This form is represented by two internal casts, both of which are parts of the ventral portions of the phragmocone. They are very similar to each other and may well be parts of the same individual. The smaller specimen is too fragmentary to warrant description; the larger one, consisting of twelve camerae, is described below.

Description.—Length as preserved about 102 mm., width (lateral diameter) near adapical end 70 mm., near adoral end 77 mm. Camerae short, about ten camerae in a length equal to lateral diameter of conch.

Sutures on ventral side broad, shallow lobes; their shape on lateral and dorsal portions not known.

¹ Found partially embedded on the surface at the top of the hill.

Siphuncle large, ventral but not marginal; holochoanoidal. Near adapical end it measures about 21 mm. in diameter and is about 5 mm. from ventral wall; near adoral end these two measurements are 24 mm. and 8 mm., respectively.

Remarks.—The most characteristic features of this form are its large siphuncle, short camerae, and sutures that form shallow, ventral lobes. It

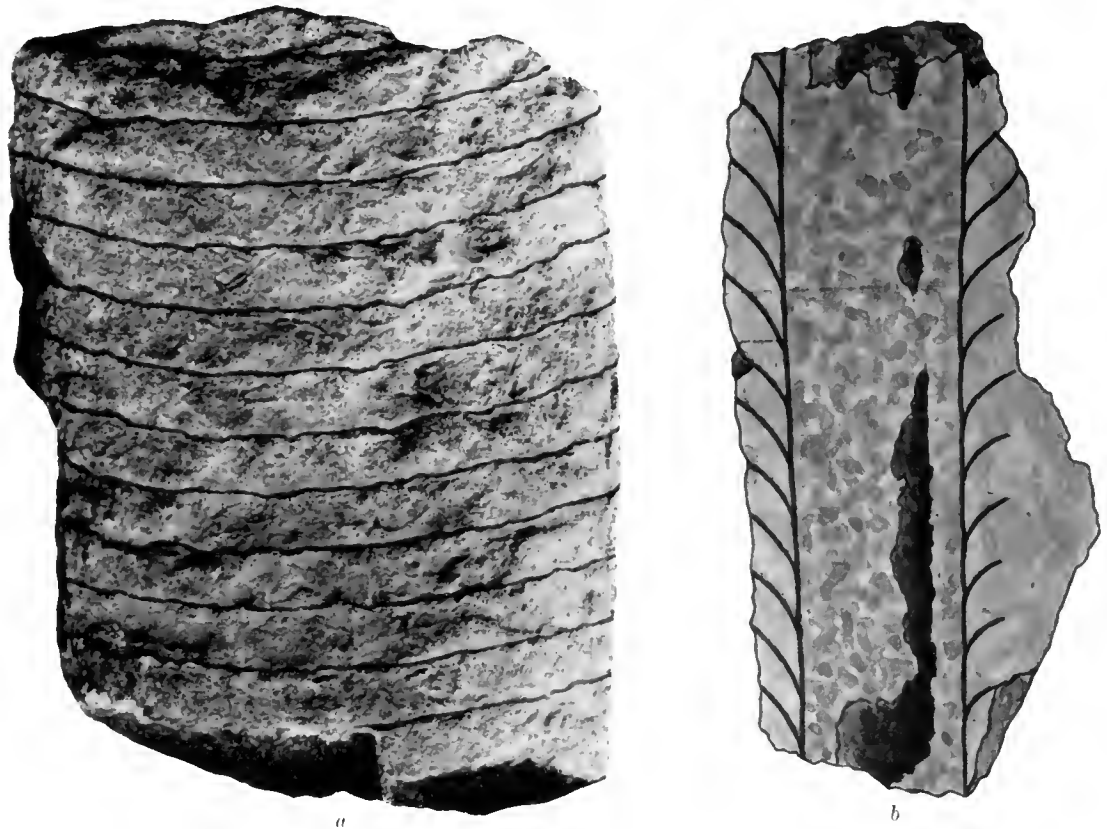


FIG. 92. *Endoceras* sp. I. F.M. No. P28856. *a*, Ventral view. *b*, Dorso-ventral section, showing siphuncle. Both natural size.

may be related to *Endoceras fulgur* (Billings) from Anticosti Island but that species has still shorter camerae in proportion to the diameter of its conch.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Ralph Robinson.

Endoceras sp. II

This form is represented by a cast of the interior of six camerae of the phragmocone.

Description.—As preserved, the specimen is 49 mm. in its greatest length, which is also the measurement of its dorso-ventral diameter at mid-length; lateral diameter 36 mm. Conch enlarges very gradually but so little of it is preserved that the exact rate of expansion cannot be determined. Due to

distortion during preservation, the dorsum of the specimen is much more convex than the venter and one of its lateral sides (right) is more rounded than the other, so that it is egg-shaped in cross section. Sutures curve apicad dorsally and ventrally and rise laterally to make broad, rounded saddles. Septa concave, joining the siphuncle with a sigmoid downward curvature.

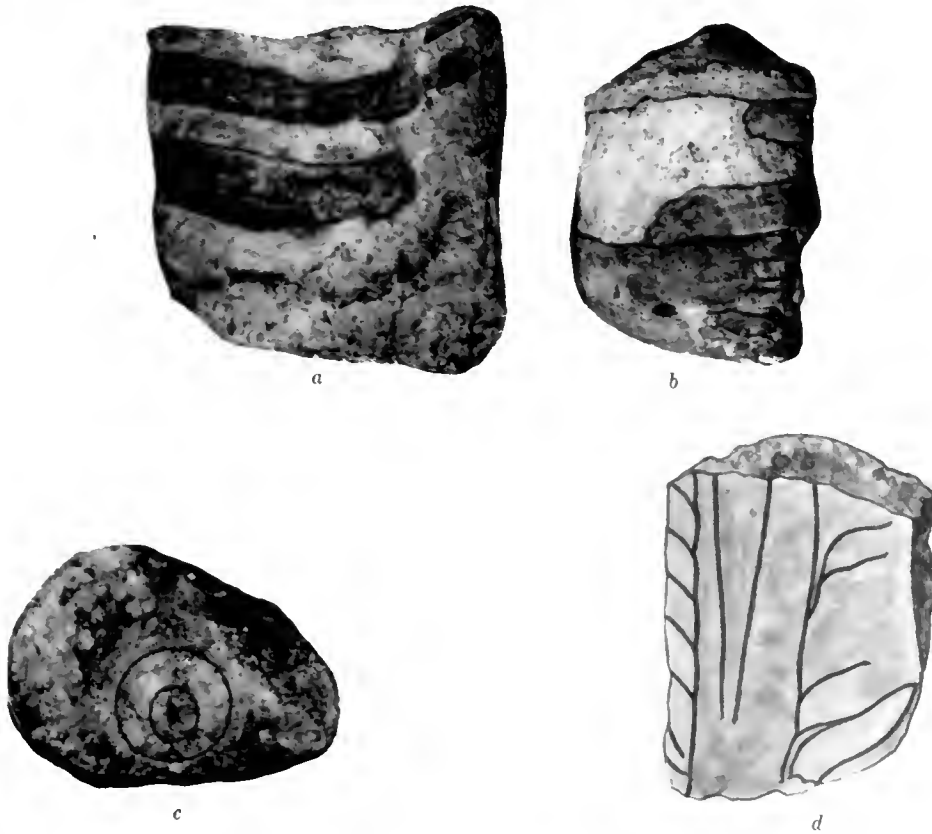


FIG. 93. *Endoceras* sp. II. F.M. No. P28857. *a*, Ventral view. *b*, Lateral view. *c*, Cross section, showing shape and position of siphuncle and endocone. *d*, Dorso-ventral section. All natural size.

Siphuncle circular in cross section, situated ventrad of center of conch. Near adoral end of specimen it is about 3 mm. from ventral wall of conch and measures 15 mm. in diameter.

Endocone located slightly ventrad of center of siphuncle; 33 mm. long (as preserved); rapidly tapering; longer dorso-ventrally than laterally, the two diameters being 7.5 mm. and 6 mm., respectively.

Remarks.—This specimen is too badly preserved for specific comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Endoceras sp. III

Remarks.—This form is represented by a single natural longitudinal section of a part of a phragmocone consisting of seven camerae, all of which are badly



a

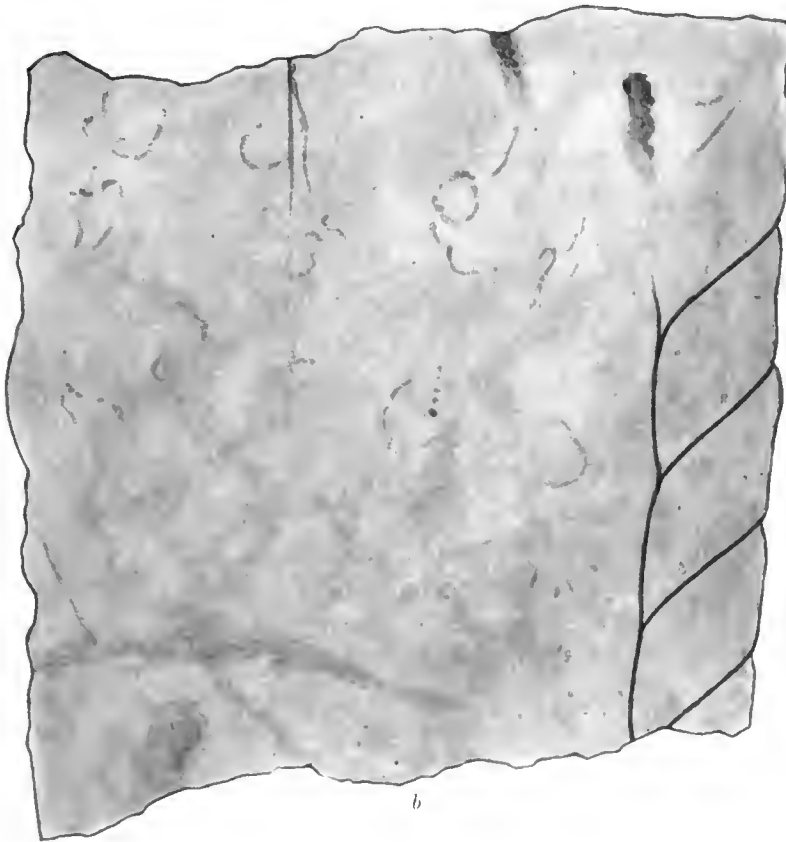


b

FIG. 94. *Endoceras* sp. III. F.M. No. P28858. a, Dorsal view. b, Ventral view, showing siphuncle exposed by natural weathering. Both natural size.



a



b

FIG. 95. *Endoceras* sp. IV. F.M. No. P28859. *a*, Ventro-lateral view. *b*, Dorso-ventral section, showing parts of siphuncle. Both natural size.

worn or damaged. As preserved, it is over 90 mm. long, with a maximum diameter of 95 mm. Average length of camerae 9 mm. Septa concave, the concavity extending to the siphuncle without sigmoid downward curvature. Shape of sutures cannot be determined.

Siphuncle large and elliptical or circular in cross section. At apical end of the specimen, lateral diameter of siphuncle is about 35 mm.

Two species to which this form may be related are *Endoceras paliforme* Miller from the Lander sandstone of Wyoming and *E. manitobense* Foerste from the Dog Head member of the Red River formation of Manitoba. The specimen under consideration, however, is so worn that it cannot be compared satisfactorily with either of these two species.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

Endoceras sp. IV

A single internal cast consisting of the left half of six camerae of the phragmocone represents this form.

Description.—Length in its present state of preservation about 115 mm.; width near adapical end about 94 mm., near adoral end about 101 mm. Cross section circular or very broadly elliptical.

Sutures slightly curved (mostly due to distortion), forming shallow, broadly rounded ventral lobes. Camerae long, averaging about 20 mm.

Siphuncle poorly preserved but large, being close to 50 mm. in diameter near adoral end; located ventrad of center of conch (about 11 mm. from ventral wall); holochoanoidal in structure.

Remarks.—The large camerae and particularly the very large siphuncle are the most characteristic features of this form. They seem to differentiate it readily from previously described species, but it is not sufficiently complete to serve as a type.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Ralph Robinson.

Suborder Orthochoanites Hyatt

Family Orthoceratidae M'Coy

Genus Ehippiorthoceras Foerste

Ehippiorthoceras Foerste, Contr. Mus. Geol., Univ. Mich., 2, No. 3, p. 86, 1924; Mem. Geol. Surv. Canada, 145, pp. 71-72, 1925; Contr. Mus. Paleont., Univ. Mich., 3, No. 3, p. 40, 1928.

Genotype: *Orthoceras formosum* Billings, Geol. Surv. Canada, Rept. of Progress, p. 317, 1853-56 (published in 1857); Foerste, Mem. Geol. Surv. Canada, 145, p. 72, pl. 11, fig. 11, also text fig. 7, 1925.

Emended description (Foerste, 1928c, p. 40).—"Conchs orthoconic, with sutures of septa curving distinctly downward laterally, and with the segments of the siphuncle enlarging to vertically elliptical or spherical outlines, but not vertically depressed and disk-like, or nummuloidal."

Ephippiorthoceras sp. I

Remarks.—This form is represented by a single, somewhat distorted cast. It is cylindrical in shape, is about 67 mm. long and 42 mm. in diameter. In cross section it is (in its distorted condition) subcircular.

The adapical end of the specimen is an impression of a septum. Otherwise, there are no traces of septa present, and, therefore, presumably only the living



FIG. 96. *Ephippiorthoceras* sp. I. F.M. No. P28860. *a*, Ventral view. *b*, Lateral view. *c*, Outline of adapical end (impression of a septum), showing probable position of siphuncle. All natural size.

chamber is represented. The septa appear to have formed broad, shallow, rounded lateral lobes and similar dorsal and ventral saddles.

A structure on the adapical end of the specimen seems to represent the siphuncle. It is located ventrad of the center, is circular in form, and about 6 mm. in diameter (fig. 96, *c*).

The adoral end of the specimen is slightly but distinctly constricted. Most probably this represents an apertural constriction, but the state of preservation of the fossil is such that it is difficult to confirm this conclusion.

It can hardly be doubted that this specimen is a typical representative of *Ephippiorthoceras*, but because it is somewhat distorted and because the phragmocone is not preserved, it has not been possible to compare it with other described species of the genus for its specific affinity. Foerste described two species of *Ephippiorthoceras* (*E. baffinense* and *E. compressum*) from the same

locality at which the present specimen was collected, but neither of them appears to be similar.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Ehippiorthoceras sp. II

Another small, weathered, and poorly preserved specimen having some of the characteristics of *Ehippiorthoceras* is in the present collection.

Description.—Length 55 mm., representing nine camerae of phragmocone; circular or nearly so in cross section but the specimen is so worn that its shape cannot be definitely ascertained. Conch, so far as could be determined, increases gradually adorally.

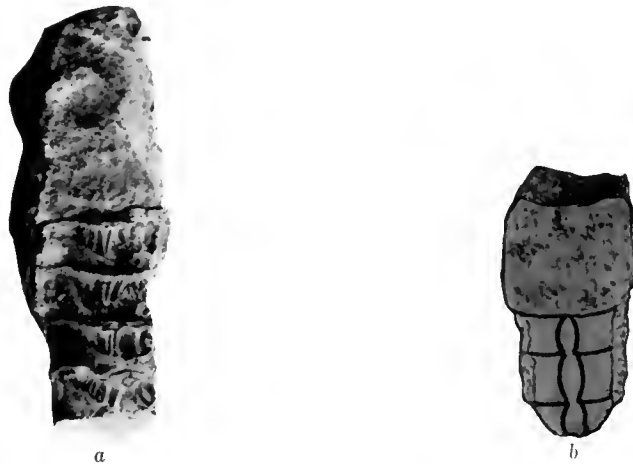


FIG. 97. *Ehippiorthoceras* sp. II. F.M. No. P28861. *a*, Ventral view. *b*, Section, showing siphuncle. Both natural size.

Sutures slightly sinuous, forming broad, shallow, ventral lobes and similar lateral saddles. Camerae rather long, their average length being 6.5 mm.

Siphuncle small, located midway between center and venter. At a break along a septum near mid-length of specimen, siphuncle about 2 mm. in diameter and about 3 mm. from venter. Segments slightly expanded within camerae; fusiform in shape. Septal necks short, slightly recurved, and about 0.5 mm. long near adoral end of specimen.

Remarks.—The siphuncle of this specimen does not appear to be expanded within the camerae as much as is typical for *Ehippiorthoceras*. It is also located relatively close to the venter. The sutures, however, are characteristic of that genus.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family *Apsidoceratidae* HyattGenus *Charactoceras* Foerste

Charactoceras Foerste, Bull. Sci. Lab. Denison Univ., 20, pp. 234-235, 1924; 30, p. 83, 1935.

Genotype: *Trochoceras*(?) *baeri* Meek and Worthen, Proc. Acad. Nat. Sci. Phila., 17, p. 263, 1865; Meek, Geol. Surv. Ohio, Paleont., 1, p. 157, pl. 13, fig. 9, 1873; Foerste, Bull. Sci. Lab. Denison Univ., 20, pp. 235-239, pl. 31, fig. 1, pl. 32, fig. 1a, b, pl. 33, fig. 1a, b, pl. 34, figs. 1a, b, 2, 1924; Troedsson, Medd. om Grønland, 71, pp. 39-40, pl. 19, fig. 1, 1926.

Emended description (Foerste, 1935, p. 83).—"Conch nautiloid, depressed dorso-ventrally, with a distinct dorsal impressed zone. The transverse striae on the surface of the shell indicate that the hyponomic sinus was broad and relatively deep but not abrupt. The sutures of the septa curve slightly downward laterally and rise higher ventrally than dorsally. The siphuncle is located on the ventral side of the conch but not near contact with the latter. The segments of the siphuncle enlarge but moderately within the camerae, being distinctly elongated lengthwise. There is no trace of transverse ribs."

Charactoceras schucherti Foerste

Eurystomites plicatus Schuchert, Proc. U. S. Nat. Mus., 22, p. 173, 1900.

Charactoceras schucherti Foerste, Bull. Sci. Lab. Denison Univ., 23, pp. 61-62, pl. 9, fig. 2a-c, pl. 27, fig. 4a-d, 1928.

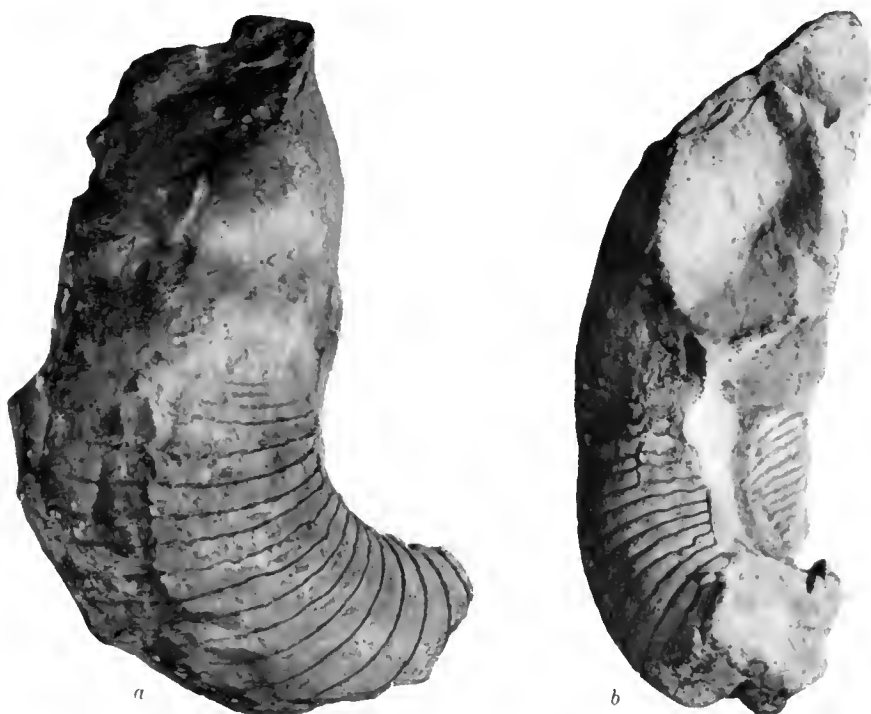


FIG. 98. *Charactoceras schucherti* Foerste. F.M. No. P28862. An incomplete cast of the interior. *a*, Lateral view. *b*, Dorso-ventral view. Both natural size.

Remarks.—This species, based on an incomplete cast of the interior (U.S.N.M. No. 28123), has been as adequately described by Foerste (1928, pp. 61–62) as his specimen permitted. The Field Museum specimen is also an interior cast and, unfortunately, except for having a little more of the living chamber preserved, it is as incomplete as Foerste's; a study of it does not add materially to the original description. Its dorso-ventral section fails to show the siphuncle, but its general form and the character of the sutures are identical with and indistinguishable from those of the species to which it has been referred.

Charactoceras plicatus (Whiteaves) (1897, pp. 225–227) from the Winnipeg limestone, which is probably of Richmond age, and *C. rotundum* Troedsson (1926, p. 40) from the Richmond portion of the Cape Calhoun series are the only two species to which the present one is closely related.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Suborder **Cyrtochoanites** Hyatt

Family **Actinoceratidae** Saemann

Genus **Actinoceras** Bronn

Actinoceras sp.

A small specimen represents the adapical portion of a species of *Actinoceras*.

Description.—As preserved, 36 mm. long; subcircular in cross section, being more broadly rounded ventrally than dorsally; conch expanded orad moderately rapidly.

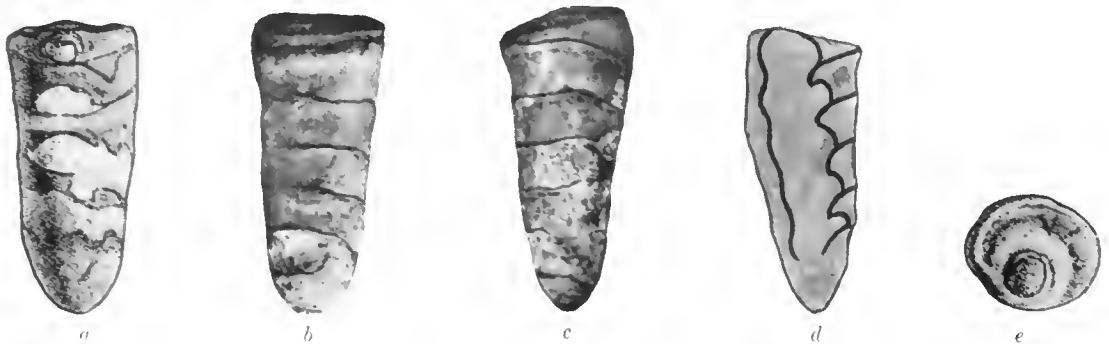


FIG. 99. *Actinoceras* sp. F.M. No. P28863. *a, b, c*, Ventral, dorsal, and lateral views, respectively. *d*, Dorso-ventral section, showing siphuncle. *e*, Cross section, showing position of siphuncle. All natural size.

Sutures straight, directly transverse on dorsal half of conch but near center of lateral sides they curve apicad and form broadly rounded ventral saddles.

Camerae relatively large; adoral four camerae average about 6 mm. in length.

Siphuncle large, segments globular, expanded within camerae (more strongly dorsally than ventrally). Near adoral end of specimen siphuncle located about 2 mm. from ventral wall of conch. Septal necks strongly recurved and a little more than 1 mm. long.

Remarks.—Inasmuch as only the adapical portion of this specimen is preserved, specific comparisons are not possible. It, however, seems to possess all essential diagnostic characters of the genus *Actinoceras*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

Genus *Leurorthoceras* Foerste

Leurorthoceras Foerste, Bull. Sci. Lab. Denison Univ., **19**, pp. 278-279, 1921; Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, p. 44, 1928.

Genotype: *Leurorthoceras hanseni* Foerste, Bull. Sci. Lab. Denison Univ., **19**, pp. 278-282, 1921; Troedsson, Medd. om Grønland, **71**, pp. 59-60, pl. 29, figs. 4, 5, 1926.

Emended description (Foerste, 1928c, p. 44).—"Conch flattened along its ventral side, the sutures of the septa with broad, ventral lobes. The location of the siphuncle is distinctly ventral, but not in contact with the ventral wall of the conch. The septal necks are distinct and relatively long. The connecting rings enlarge within the camerae, and vary from vertically elliptical to approximately globular in outline, but they are not enlarged sufficiently in a lateral direction to secure a flattened disk-like appearance, as in typical *Actinoceras*."

Leurorthoceras(?) *baffinense* Foerste

This species is represented by an internal cast of the ventral half of thirteen camerae of the phragmocone.

Description.—Length as preserved about 220 mm., maximum width about 125 mm., not expanded appreciably adorally.

Sutures form broadly rounded, shallow lobes on ventral side; their course on lateral and dorsal sides is not known.

Length of camerae varies, but average about 17 mm.

Siphuncle not preserved internally, as shown by a dorso-ventral section. Externally, on weathered surface, it appears to be ventral and large, having a diameter of more than 25 mm. near adapical end and composed of segments that are greatly expanded within the camerae.

Remarks.—Both the holotype of this species and the specimen under consideration are very incomplete. Nevertheless, all of their characters that can be determined seem to coincide so closely that they are almost certainly conspecific.

Leurorthoceras(?) *baffinense* is from the Richmond of Putnam Highland, Baffin Land.



FIG. 100. *Leurorthoceras(?) baffinense* Foerste. F.M. No. P28864. Ventral side; natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Leurorthoceras(?) cf. *L. baffinense* Foerste

Remarks.—The specimen representing this form is so fragmentary that it does not admit of satisfactory comparison with known species. Beyond the fact that the downward curvature of the sutures (lobes) of its ventral side is



FIG. 101. *Leurorthoceras(?)* cf. *L. baffinense* Foerste. F.M. No. P28865. A fragment of the ventral side of the phragmocone; natural size.

similar to that in *L. baffinense* Foerste, and that the length of the camerae in both are about the same, there are no other details preserved for comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Kochoceras* Troedsson

Kochoceras Troedsson, Medd. om Grønland, 71, p. 65, 1926; Foerste, Bull. Sci. Lab. Denison Univ., 30, p. 58, 1935.

Genotype: *Kochoceras cuneiforme* Troedsson, Medd. om Grønland, 71, pp. 68–71, pl. 37, figs. 2–4, pl. 38, pl. 39, pl. 40, figs. 1–2, pl. 44, fig. 6, 1926; Foerste, Bull. Sci. Lab. Denison Univ., 30, p. 58, 1935; Teichert, Rept. Fifth Thule Exped., 1921–24, Gyldendalske Boghandel, Nord. Forlag, 1, No. 5, p. 96, pl. 19, fig. 7, 1937.

Original description.—"Breviconic or rarely longiconic orthoceracones with flattened ventral side and actinoceroid siphuncle. The latter is large, almost filling up the apical portion of the conch, and is tightly pressed against the ventral side of the conch until flattening and confluence of the annulations."

Revised description (Foerste, 1935, p. 58).—"Conchs closely similar to *Actinoceras*, but the ventral side is strongly flattened, the lateral sides rounding rapidly into the much more broadly rounded dorsal side of the conch. The siphuncle is depressed dorso-ventrally and is in flattened contact with the ventral wall of the conch. The contact areas on the connecting rings usually are broad and conspicuous, the septal necks being free from contact. Successive segments of the siphuncle usually diminish in diameter dorso-ventrally and even laterally."

***Kochoceras troedssoni* Roy, sp. nov.**

This species is represented by a part of a phragmocone consisting of nine camerae, most of which are broken or otherwise damaged. Its interior is also filled with crystalline calcite. It has, therefore, not been possible to make a dorso-ventral section to examine the structure of the siphuncle as clearly as is desirable.

Description.—Length as preserved 142 mm. Conch subelliptical in cross section, the ventral side being distinctly flattened and the dorsal side strongly convex, almost semi-circular. Apical end represents a septum which is subconical, its angle of inclination being much less on the ventral than on the dorsal side. At adoral end of this septum, lateral diameter of conch is about 51 mm. and dorso-ventral diameter about 37 mm., whereas near adoral end of specimen the estimated diameters are 104 mm. and 44 mm., respectively. Rate of lateral expansion is 24 mm. in a length of 55 mm.

Siphuncle large, nummuloidal, as may be deduced from its segments, which are greatly expanded within the camerae. At apical end of the specimen the siphuncle is about 14 mm. in diameter, but near mid-length it attains a diameter of about 35 mm. within the camerae. Presumably segments of siphuncle are in contact with ventral wall of conch within the camerae, but not at their junction with the septa.

Diagnosis.—Of the various species referred to this genus, only two, namely, *Kochoceras cuneiforme* Troedsson, from the Richmond of Cape Calhoun, Greenland, and *K. sublentiforme* Miller, from the Lander sandstone of Wyoming, may be mentioned here as related to the present species. The Greenland species, however, has a larger apertural angle, and the one from Wyoming has shorter camerae. The lobes of the sutures on the ventral side of the latter species are also distinctly deeper.

Remarks.—When Troedsson established the genus *Kochoceras* (1926, pp. 65–66), he apparently mistook a septum for the adapical end of the conch. This becomes clear when one examines the form of the fifth septum from the apical end of the holotype of *K. magnicameratum* Miller (1932, pl. 22, fig. 2).

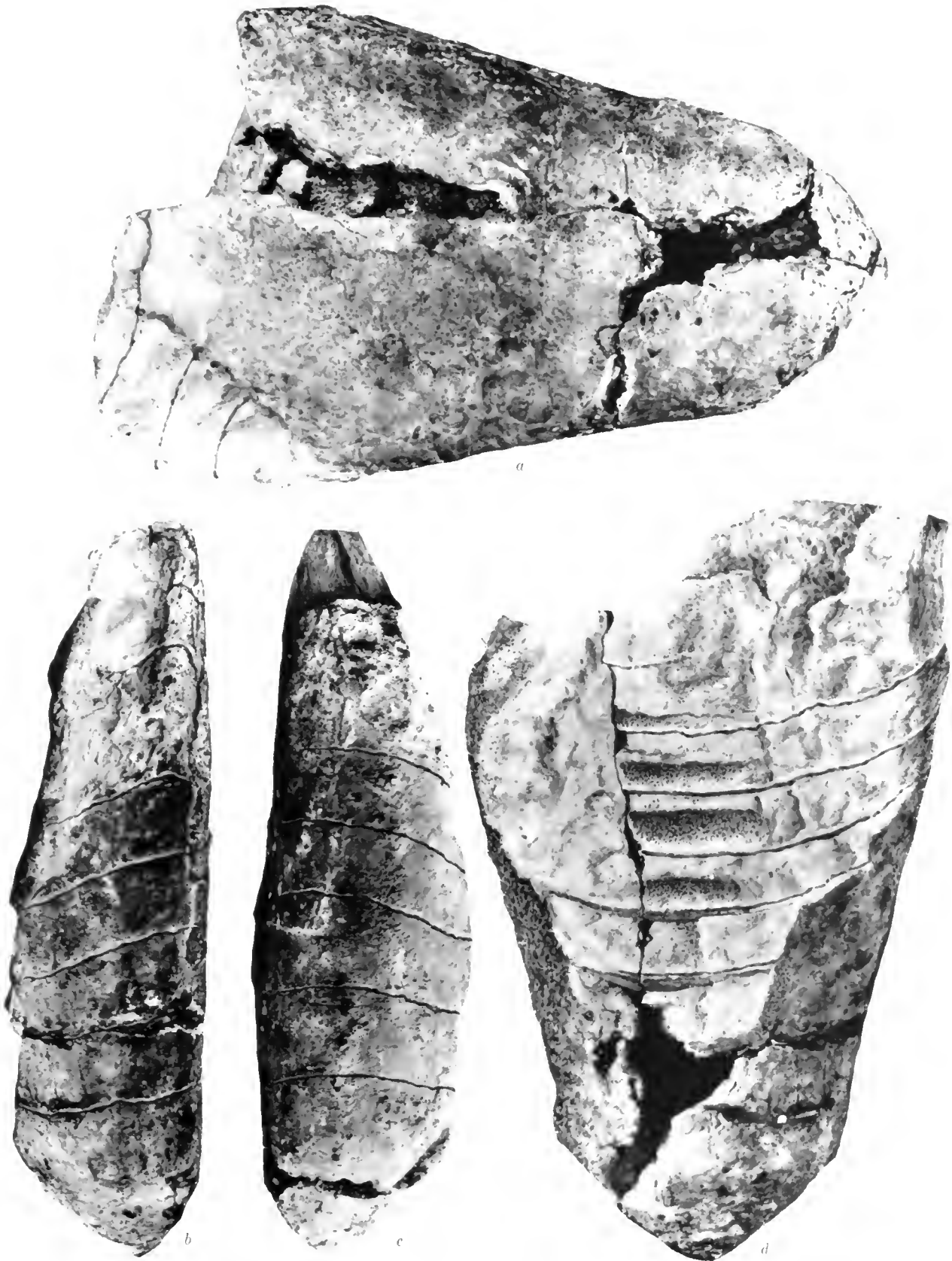


FIG. 102. *Kochoceras troedssoni* Roy, sp. nov. F.M. No. P28866. Holotype. *a*, Dorsal side. *b*, *c*, Lateral sides. *d*, Ventral side. All natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28866.

Kochoceras sp.

Remarks.—This fragment, consisting of only three segments of a siphuncle, almost certainly represents the genus *Kochoceras*, and perhaps it is conspecific with *K. troedssoni* Roy. Its poor state of preservation, however, does not permit more certain identification.

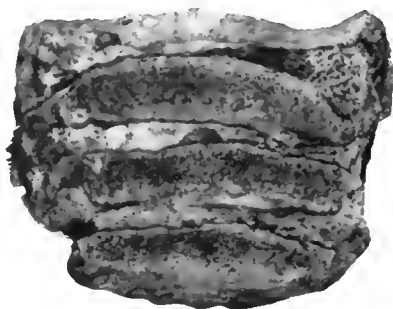


FIG. 103. *Kochoceras* sp. F.M. No. P28867. Dorsal view of three segments of siphuncle. Natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family Onoceratidae Hyatt

Genus Westenoceras Foerste

Westenoceras Foerste, Bull. Sci. Lab. Denison Univ., **20**, pp. 253-254, 1924; Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, p. 48, 1928; Bull. Sci. Lab. Denison Univ., **30**, p. 59, 1935.

Genotype: *Cyrtoceras manitobense* Whiteaves, Trans. Roy. Soc. Canada, **7**, sec. 4, p. 80, pl. 13, figs. 3-5, pl. 15, fig. 4, 1890; Foerste, Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, pp. 49-50, pl. 5, fig. 1, pl. 11, fig. 5, 1928.

Emended description (Foerste, 1935, p. 59).—"Conchs curved lengthwise, with the ventral side convex, this convexity being accentuated at a hump 4 or 5 camerae beneath the base of the living chamber ventrally. A much smaller gibbosity is shown by the dorsal outline along the upper part of the phragmocone, a short distance beneath the living chamber; the lower part of the phragmocone and the upper part of the living chamber here tend to be faintly concave. The sutures of the septa curve downward laterally, the maximum depth of the resulting lobes being dorsal of the center of the conch. The ventral saddles rise higher than the dorsal ones and are distinctly subangular. The siphuncle is near, but not in contact with the ventral wall of the conch. Its segments are barrel-

shaped, narrowing abruptly where near contact with the septa, with a narrow passage through the septa, their lateral sides being gently convex in vertical sections."

Westenoceras greggi Roy, sp. nov.

This species is represented by a fairly well-preserved cast of the interior, consisting of twenty-five camerae of the phragmocone and about 34 mm. of the living chamber. The specimen, however, is broken into two pieces and a portion of the left lateral side of the living chamber and at least the seventh and eighth camerae apicad of the junction of the living chamber and the phragmocone are missing. It is thus difficult to place these two broken and separated parts in their exact position, although there is a matrix contact. The description given here of the form of the individual (as if it were intact) is, therefore, subject to a slight amount of error.

Description.—Total length (of the two separated parts referred to above) at mid-line of right lateral side about 175 mm. Ventral side moderately convex in vertical outline, its maximum convexity being between the sixth and ninth camerae (unfortunately the missing ones); dorsal side slightly concave though apparently slightly convex near the junction of phragmocone and living chamber. Conch exogastrically curved; cross section of well-preserved portion of phragmocone subcircular. Dorso-ventral diameter of apical end of specimen 18 mm., of the fifteenth camera orad of apical camera 47 mm., an expansion of 29 mm. within a distance of 87 mm. Adapical 45 mm. of phragmocone and preserved portion of living chamber depressed laterally and weathered to such a degree that their original forms are more or less lost. Adoral end of living chamber subcircular (inferred), its dorso-ventral diameter at least 42 mm., the other diameter about 32 mm. (both measurements estimated). Surface of specimen marked by numerous low, broad, longitudinal ribs separated by narrow, shallow grooves.

Sutures on lateral sides nearly perpendicular to long axis of conch, rising but slightly ventrally and dorsally to form broad, rounded saddles.

Camerae increase in length anteriorly; length of apical one of specimen 4 mm. and the sixteenth one 7 mm. Septa concave but the concavity increases very gradually anteriorly. Concavity of a septum near mid-length measures about 8 mm.

Siphuncle circular; situated close to ventral wall of conch. At apical camera of specimen it is hardly 2 mm. away from the wall; at mid-length the distance is about 9 mm. Its maximum diameters at these two points are 5 mm. and 13 mm., respectively. Segments greatly expanded within camerae and siphuncle is nummuloidal in structure. Septal necks strongly recurved. Apparently there were annular deposits inside the siphuncle on the septal necks, but the state of preservation of the internal structures of the specimen does not permit the precise nature of these deposits to be determined.

Diagnosis.—This species is related to *W. deckeri* Foerste of the upper Viola of Oklahoma but it differs in having a smaller apical angle and longer camerae.

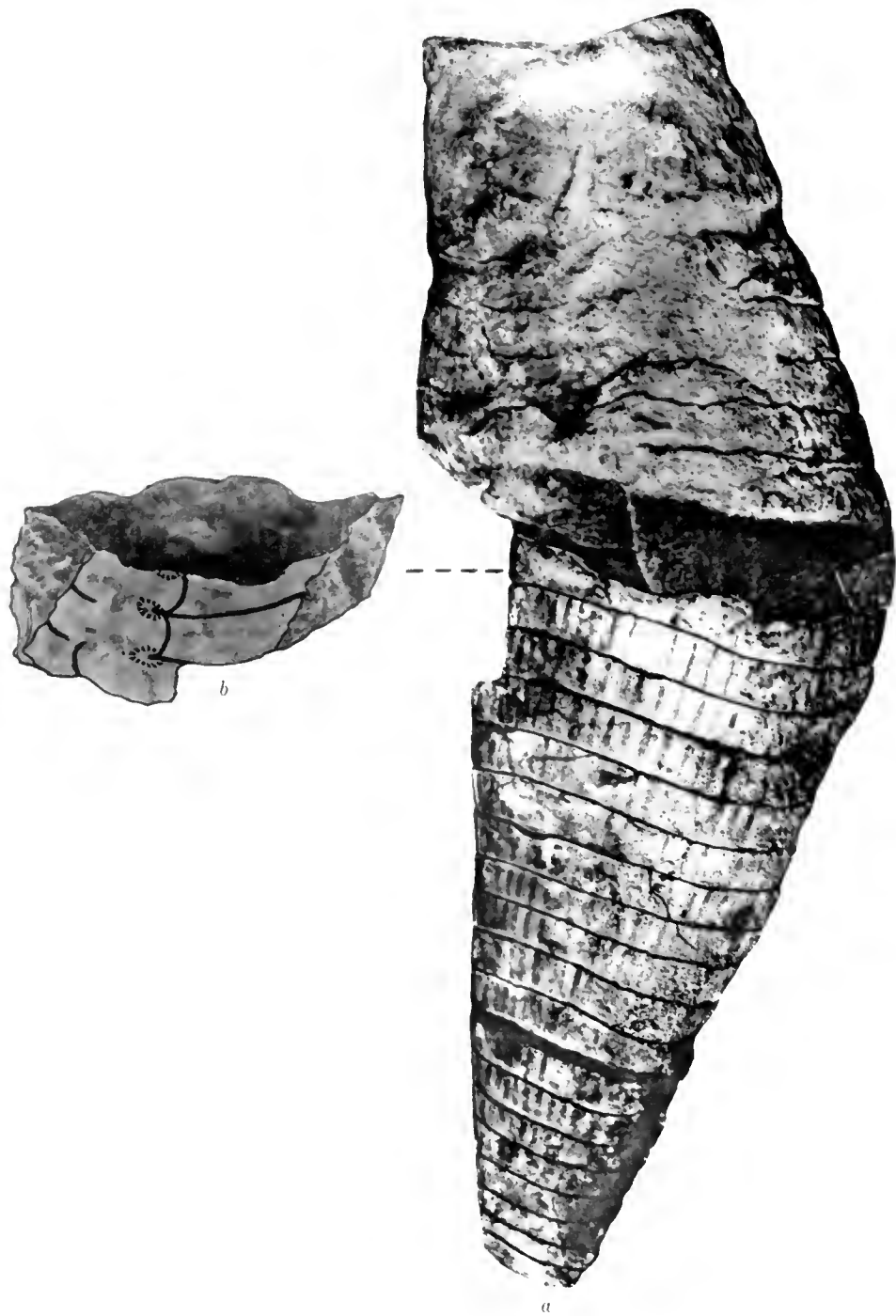


FIG. 104. *Westenoceras greggi* Roy, sp. nov. F.M. No. P28868. Holotype. *a*, Lateral view. *b*, Dorso-ventral vertical section of ninth, tenth, and eleventh camerae, showing siphuncle and annular deposits inside the siphuncle on the septal necks. Both natural size.

The specific name is in honor of Major Clifford C. Gregg, Director of Field Museum of Natural History.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28868.

Genus *Winnipegoceras* Foerste

Winnipegoceras Foerste, Contr. Mus. Paleont., Univ. Mich., 3, No. 3, pp. 55–56, 1928; Bull. Sci. Lab. Denison Univ., 30, p. 38, 1935.

Genotype: *Cyrtoceras laticurvatum* Whiteaves, Geol. Surv. Canada, Paleont. Fossils, 3, pt. 3, p. 224, text fig. 14, 1897; Foerste, Contr. Mus. Paleont., Univ. Mich., 3, No. 3, pp. 56–58, pl. 9, figs. 1, 2, 1928; Bull. Sci. Lab. Denison Univ., 30, pp. 38–39, pl. 4, fig. 2, 1935.

Original description.—“Conch strongly curved in a lengthwise direction, with the ventral side convex and the dorsal side strongly concave, differing in this respect from *Westenoceras*, in which the lengthwise curvature is relatively small, the dorsal outline being slightly gibbous along the upper part of the phragmocone and the lower part of the living chamber. In *Winnipegoceras* the conch is humped along the upper part of its ventral outline at a point five or six camerae below the base of the living chamber, and this chamber is long and attenuated toward the aperture, as in the genus named. Although the vertical dorso-ventral section through the genotype passes directly through the center of the siphuncle for most of its length, the details of structure of this siphuncle still remain vague.”

Emended description (Foerste, 1935, p. 38).—“The holotype resembles the genus here called *Neumatoceras* in the enlargement of the conch to a point distinctly below the base of the living chamber, the remainder of the phragmocone and the lower part of the living chamber tapering thence upward. The conch of *Winnipegoceras*, however, attains a much larger size, curves more strongly lengthwise considering its size, and the living chamber is much longer.”

Winnipegoceras laticurvatum (Whiteaves)

Cyrtoceras laticurvatum Whiteaves, Geol. Surv. Canada, Paleont. Fossils, 3, pt. 3, p. 224, text fig. 14, 1897.

Winnipegoceras laticurvatum (Whiteaves), Contr. Mus. Paleont., Univ. Mich., 3, No. 3, pp. 56–58, pl. 9, figs. 1, 2, 1928.

Remarks.—This species is represented by an incomplete cast of the interior consisting only of 60 mm. (measuring medially on the lateral side) of the living chamber and the adoral six camerae of the phragmocone. The preserved portion of the phragmocone is about 23 mm. long. The camerae average almost 5 mm. in length, but the adoral two camerae are very short. The specimen strongly resembles *Winnipegoceras laticurvatum* (Whiteaves) and seems conspecific with it. The degree of convexity of its ventral and dorsal sides respectively appears to

be essentially the same as that of *W. laticurvatum*. The elliptical cross section of its living chamber as well as the downward curvature of its sutures of the lateral zone are also quite identical. The siphuncle of the present specimen has not been observed, but presumably it is near the convex outline of the conch, which is very poorly preserved.

W. laticurvatum has been reported from the Red River formation of Manitoba and the Lander sandstone of Wyoming. Closely similar forms occur in the



FIG. 105. *Winnipegoceras laticurvatum* (Whiteaves). F.M. No. P28869. Lateral view; natural size.

Whitewood dolomite of the Black Hills, South Dakota, and in the Matapedia series of Quebec, Canada.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Neumatoceras* Foerste

Neumatoceras Foerste, Bull. Sci. Lab. Denison Univ., 30, p. 31, 1935.

Genotype: *Neumatoceras gibberosum* Foerste, Bull. Sci. Lab. Denison Univ., 30, pp. 32-33, pl. 2, figs. 3, 4, 1935.

Original description.—"The genus *Neumatoceras* differs from *Beloitoceras* chiefly in being distinctly humped along the upper part of the ventral outline of the phragmocone, the maximum dorso-ventral diameter usually being at a distinct interval beneath the base of the living chamber ventrally. From this level of maximum dorso-ventral diameter the conch usually tapers conspicuously toward the aperture. The dorsal outline along the upper part of the phragmocone

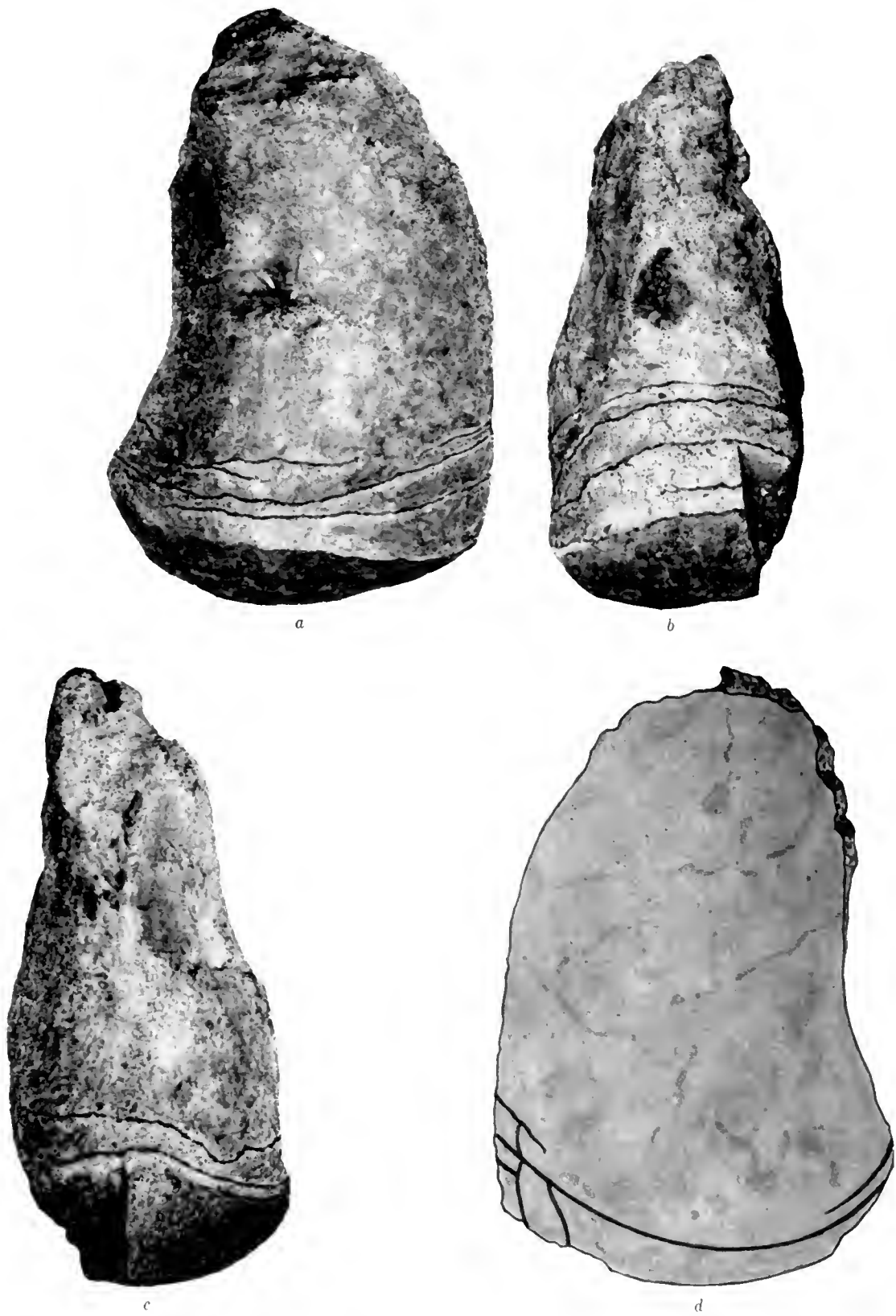


FIG. 106. *Neumatoceras(?) tumidum* (Schuchert). F.M. No. P28870. *a*, Lateral view. *b*, Ventral view. *c*, Dorsal view. *d*, Dorso-ventral section, showing portion of siphuncle. All natural size.

and all of the living chamber tends to be relatively straight, with faint incurvature at top and along the lower part of the phragmocone."

***Neumatoceras(?) tumidum* (Schuchert)**

Oncoceras tumidum Schuchert, Proc. U. S. Nat. Mus., **22**, p. 172, pl. 14, figs. 1, 3, 1900.

Westenoceras(?) tumidum (Schuchert), Bull. Sci. Lab. Denison Univ., **23**, pp. 102-103, pl. 8, fig. 7a, b, 1928.

Neumatoceras(?) tumidum Foerste, Bull. Sci. Lab. Denison Univ., **30**, p. 32, 1935.

Remarks.—This species was first described by Schuchert (1900, p. 172) as *Oncoceras tumidum*. Foerste (1928, pp. 102-103) redescribed it as *Westenoceras(?) tumidum* (Schuchert), and later (1935, p. 32) indicated that probably it should be referred to *Neumatoceras*. He knew only the adoral portion of the phragmocone and was unable to find any trace of the siphuncle; therefore, he was uncertain as to its generic identity. The specimen now available represents also only the living chamber and the adoral camerae of the phragmocone. A median dorso-ventral section of the specimen, however, shows that the siphuncle is located close to the ventral side of the conch, is small in size, and is composed of subfusiform segments. The septal necks appear to be short and strongly recurved.

Compared to the holotype of *N.(?) tumidum*, the present specimen is about 30 per cent larger and may represent a distinct species. All of its characters that can be determined, however, do not seem to differ materially from those of the specimen (holotype) originally described by Schuchert. Congeneric forms are known from the upper Ordovician at several localities in Wyoming; near Canyon City, Colorado; and possibly in southern Manitoba and west of Hudson Bay.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family Phragmoceratidae Hyatt

Genus *Cyrtogomphoceras* Foerste

Cyrtogomphoceras Foerste, Bull. Sci. Lab. Denison Univ., **20**, p. 267, 1924; Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, pp. 58-59, 1928; Bull. Sci. Lab. Denison Univ., **30**, pp. 71-72, 1935.

Genotype: *Oncoceras magnum* Whiteaves, Trans. Roy. Soc. Canada, **7**, pt. 4, p. 79, pl. 15, fig. 1, 1890; Foerste, Contr. Mus. Paleont., Univ. Mich., **3**, No. 3, pp. 59-60, pl. 6, fig. 1, 1928.

Emended description (Foerste, 1935, pp. 71-72).—"Conchs with convex ventral outline, the dorsal outline being slightly gibbous along the top of the phragmocone and the lower part of the living chamber, but more or less distinctly concave along the upper part of the living chamber and the lower part of the phragmocone. The sutures of the septa are nearly directly transverse to the curving vertical axis of the conch along the lower part of the phragmocone

but rise at an increasing angle toward the upper part of the phragmocone, this rise becoming conspicuous near the base of the living chamber. This chamber tapers conspicuously toward its aperture, the margin of the aperture sloping conspicuously downward in a ventral direction, being approximately parallel to the uppermost sutures of the septa. Surface of shell with coarse transverse raised lines which slope downward toward the more convex side of the conch, showing that the latter is to be regarded as ventral, notwithstanding the slope of the aperture at gerontic stages of growth. The siphuncle is located near, but not in contact with the dorsal side of the conch, its location being endogastric. The segments of the conch are nummuloidal, low and broad, but not in contact with the adjacent wall of the conch."

Cyrtogomphoceras baffinense Foerste

Cyrtogomphoceras baffinense Foerste, Contr. Mus. Paleont., Univ. Mich., 3, No. 3, pp. 63-65, pl. 4, fig. 1, pl. 11, fig. 4, 1928.

Remarks.—This species is represented by a single specimen which is a fairly complete right lateral half of the conch. It is weathered, exposing the siphuncle. In general outline and disposition of the sutures it is certainly very close to the species to which it has been referred. It is, however, a smaller form, although mature, as can be judged by the shorter camerae near the adoral end of the phragmocone. The siphuncle is located close to the ventral side and may have been in contact with the wall of the conch. The siphuncle is num-

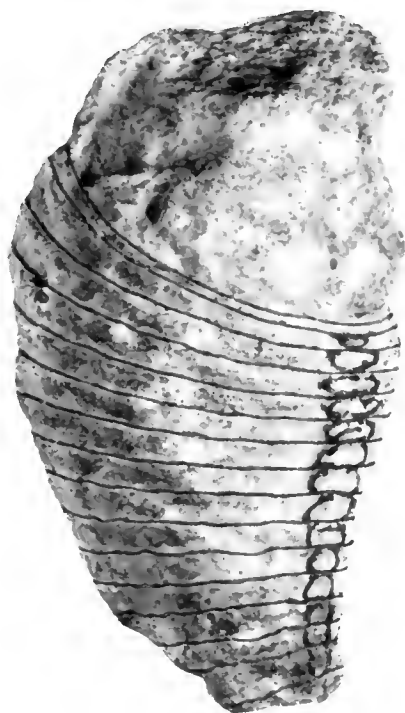


FIG. 107. *Cyrtogomphoceras baffinense* Foerste. F.M. No. P28871. A weathered right lateral half, exposing the siphuncle. Natural size.

muloidal in structure and its segments attained a maximum diameter of at least 11 mm.

This species is a typical representative of the genus *Cyrtogomphoceras*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

***Cyrtogomphoceras furnishi* Roy, sp. nov.**

A single cast of the interior, consisting of the adapical 15 mm. of the living chamber and the adoral eight camerae of the phragmocone, represents the holotype of this species.

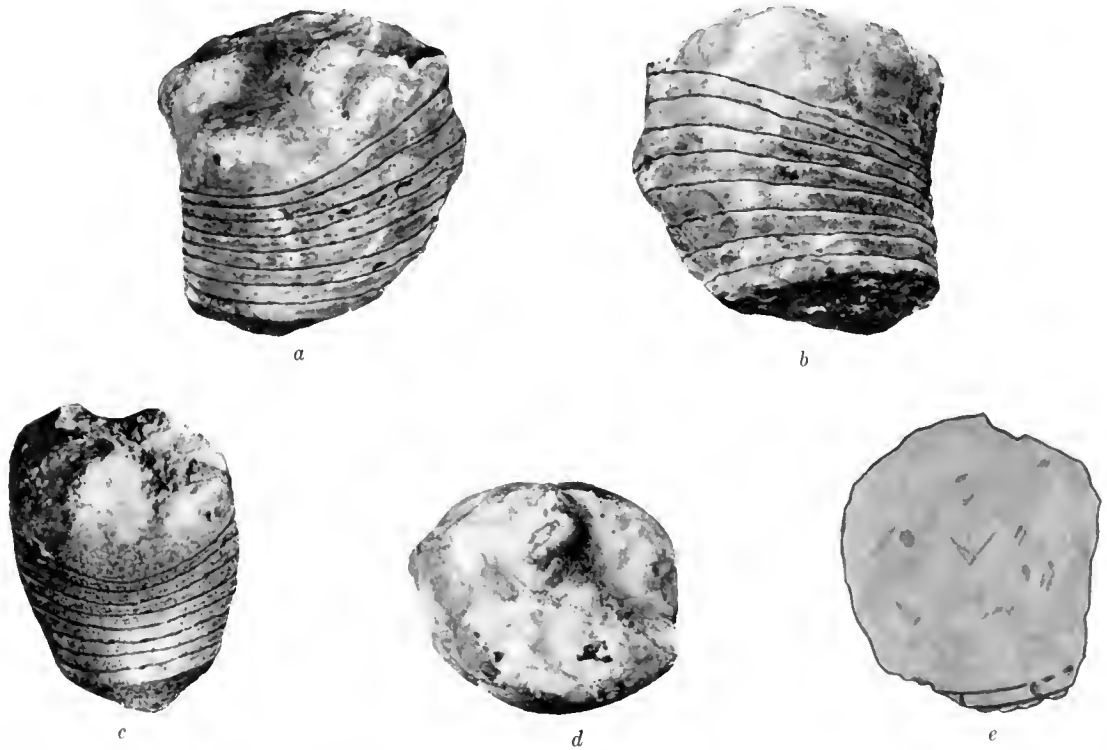


FIG. 108. *Cyrtogomphoceras furnishi* Roy, sp. nov. F.M. No. P28872. Holotype. *a*, Left lateral view. *b*, Right lateral view. *c*, Ventral view. *d*, Apertural view. *e*, Dorso-ventral section, showing a segment of siphuncle close to venter. All natural size.

Description.—Conch slightly curved endogastrically; elliptical in cross section. Length as preserved 40 mm.; maximum dorso-ventral diameter slightly apicad of junction of phragmocone and living chamber also 40 mm. Near adoral end of holotype, dorso-ventral diameter, or height, about 36 mm.; lateral diameter, or width, about 31 mm.

Sutures on adapical portion approximately straight and transverse to long axis of conch, rising progressively higher along dorso-lateral sides and forming rounded saddles on crossing the dorsum. On ventral side sutures appear to bend apicad, giving rise to shallow, rounded lobes.

Siphuncle preserved only in apical camerae of specimen; situated close to venter but not in contact with ventral wall of conch. Diameter of siphuncle at adapical end at least 5 mm. Septal necks strongly recurved and segments of siphuncle greatly expanded within the camerae. Siphuncle is thus cyrtochaonic in structure and nummuloidal.

Diagnosis.—This species does not seem to be closely related to any described form. Specific comparisons, therefore, are not necessary.

Remarks.—This species is named in honor of Dr. W. M. Furnish, of the University of Iowa.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28872.

Cyrtogomphoceras sp. I

Remarks.—This poorly preserved specimen consists of only a portion of the living chamber and parts of eleven camerae. As preserved, it is 109 mm. long and seems to have attained its maximum diameter (77 mm.) a little apicad of the junction of the phragmocone and the living chamber. The sutures of the adoral part of the phragmocone appear to rise as rapidly along the dorsal part of the conch as is typical of the genus and they are very similar to those of *Cyrtogomphoceras cf. baffinense* Foerste (1928, pl. 4, fig. 2). The siphuncle is moderately large and is nummuloidal in structure. In the apical half of the specimen it is located about 5 mm. from the ventral wall of the conch and is practically the same as that of the siphuncle of *C. cf. baffinense*. It is possible that the two are conspecific but the data at hand are not adequate for certain identification.

C. cf. baffinense is from the Richmond of Putnam Highland, Baffin Land.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

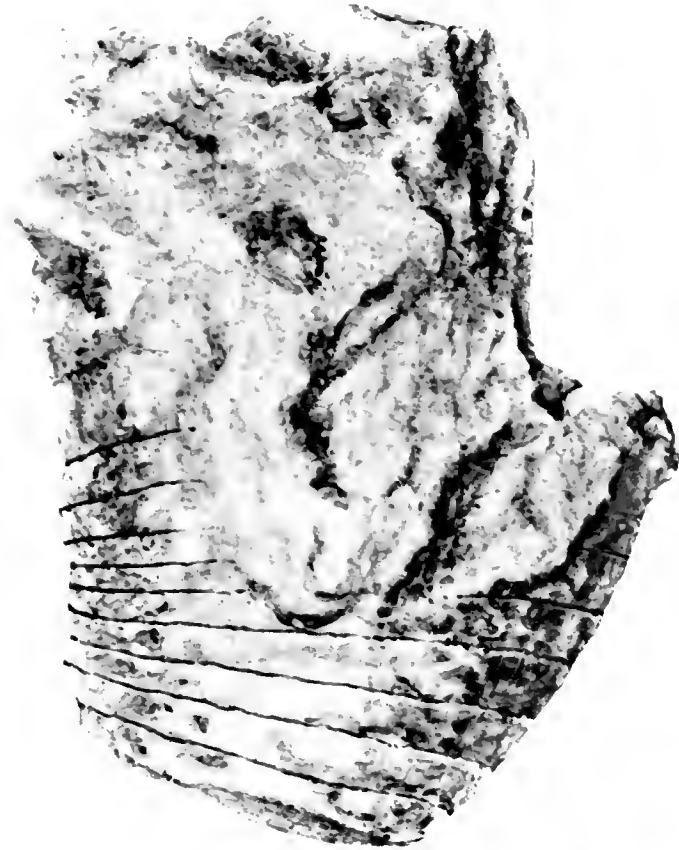
Collector.—John Jaynes.

Cyrtogomphoceras sp. II

A single internal cast of an incomplete left half of the conch represents this form. Only the adapical 25 mm. of the living chamber and the adoral eight camerae of the phragmocone are preserved.

Description.—Conch slightly curved endogastrically. Length as preserved (measured along mid-line) about 70 mm.; maximum width slightly apicad of junction of phragmocone and living chamber 45 mm.

Sutures near adapical end nearly straight and approximately transverse to long axis of conch but adorally they rise progressively along dorso-lateral side and form rounded dorsal saddles and rounded ventral lobes.



a



b

FIG. 109. *Cyrtogomphoceras* sp. I. F.M. No. P28873. a, Lateral view. b, Dorso-ventral view, showing a portion of siphuncle. Both natural size.

Camerae measured along lateral side of conch average about 5 mm. (adoral two are much shorter, indicating that the specimen had attained at least late maturity).

Siphuncle poorly preserved, ventral in position and nummuloidal in form; located very close to ventral wall of conch and may have been in contact with it.

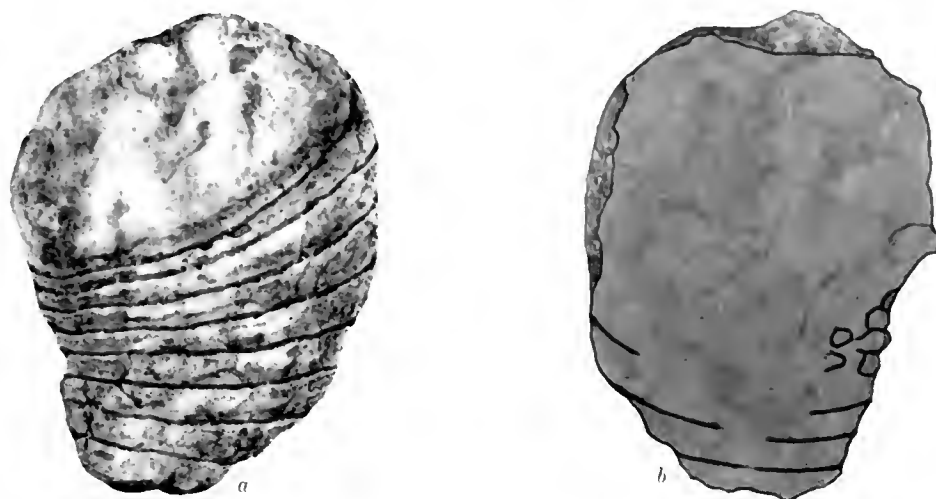


FIG. 110. *Cyrtogomphoceras* sp. II. F.M. No. P28874. *a*, Lateral view. *b*, Dorso-ventral half, showing portion of siphuncle. Both natural size.

Remarks.—This specimen is so incomplete that specific comparisons are not possible. Its general shape, its sutures, and particularly the nature and position of its siphuncle indicate clearly, however, that it is congeneric with *Cyrtogomphoceras*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Diestoceras* Foerste

Diestoceras Foerste, Bull. Sci. Lab. Denison Univ., **20**, p. 262, 1924; **30**, pp. 61–62, 1935.

Genotype: *Gomphoceras indianense* Miller and Faber, Jour. Cincinnati Soc. Nat. Hist., **17**, p. 137, pl. 7, figs. 3–5, 1894; Foerste, Bull. Sci. Lab. Denison Univ., **20**, p. 263, pl. 25, fig. 1a, b, pl. 26, figs. 1a, b, 2a, b, pl. 27, fig. 2, 1924.

Emended description (Foerste, 1935, pp. 61–62).—“The genotype is a breviconic erect conch, moderately compressed laterally. The conch enlarges as far as the top of the phragmocone and then contracts along the living chamber toward the aperture. At the aperture the marginal part of the wall of the living chamber curves distinctly inward, in a horizontal direction, for a distance of 3 or 4 millimeters. The outline of this aperture tends to be oval, with its ventral side more narrowly rounded. This locates the ventral side of the conch. The

vertical outline most distant from the siphuncle is slightly more convex than that nearest the latter, and the total length of the camerae along this more convex side of the conch is greater than on its siphuncle side, the sutures of the upper septa tending to rise higher here. From this it is assumed that the affinity of the genus *Diestoceras* is with that of endogastric conchs. The siphuncle appears to be nummuloidal, and is near the dorsal wall of the conch but not in actual contact with the latter. The surface of the shell is striated transversely, these striae curving downward on the ventral side of the conch, thus locating former positions of the hyponomic sinus."

***Diestoceras milleri* Roy, sp. nov.**

Only a single cast referable to this genus was collected. Unfortunately, it is badly deformed.

Description.—In its present state this species is about 180 mm. long. The phragmocone is rapidly expanded orad, and consists of eleven camerae, all decreasing progressively in length adorally. The adapical camera is about 12 mm. long, and the adoral one measures only 3 mm. The presence of this particularly short adoral camera indicates that the specimen has attained late maturity and presumably reached its maximum size.

The sutures appear to have been essentially straight and approximately perpendicular to the long axis of the conch.

The siphuncle is dorsal and marginal in position. It is located on the left side of the specimen. The segments of the siphuncle are greatly expanded within the camerae, attaining a maximum diameter of approximately 25 mm. near the adapical end of the specimen. A dorso-ventral section through the siphuncle failed to show the internal structures.

Diagnosis.—The only described species of this genus that remotely resembles the present one is *Diestoceras magister* Foerste from the Lander sandstone of the Big Horn formation, Wyoming. That species, however, is a much larger form with relatively shorter camerae than the specimen under consideration. The Wyoming species has also a decidedly more rotund appearance.

Remarks.—The specific name is in honor of Dr. A. K. Miller, of the University of Iowa.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28875.

Phylum **ARTHROPODA**

Class **Crustacea**

Subclass **Trilobita**

The trilobites, though not abundant at the head of Frobisher Bay, are represented by all three orders: the Hypoparia by a single genus, *Harpes*; the

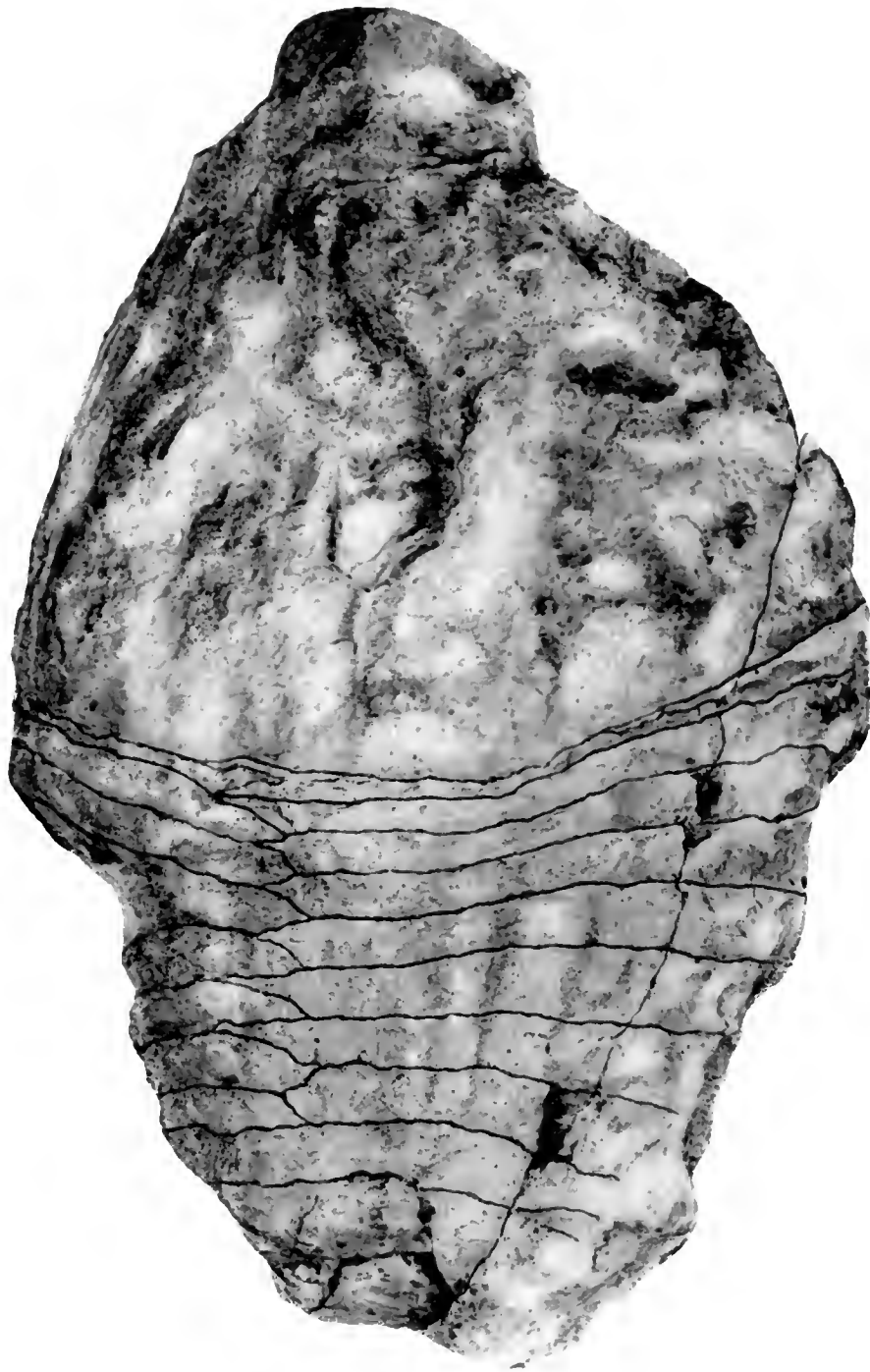


FIG. 111. *Diestoceras milleri* Roy, sp. nov. F.M. No. P28875. Lateral view, showing traces of siphuncle to left (dorso-lateral). Natural size.

Opisthoparia by five genera, *Ischyrotoma*(?), *Remopleurides*, *Isotelus*, *Illaenus*, and *Bumastus*; and the Proparia by seven, *Encrinurus*, *Calymene*, *Ceraurus*, *Ceraurinus*, *Pterygometopus*, *Calyptaulax* and *Eomonorachus*, a total of thirteen genera. These genera embrace twenty-one species and varieties, of which ten (apparently all new) have been determined. The remaining eleven, because of their fragmentary condition, can not be satisfactorily identified.

Order **Hypoparia** Beecher

Family **Harpedidae** Corda

Genus **Harpes** Goldfuss

Harpes sp. ind.

Remarks.—This form is represented by three fragments of cephalic shields. None of these, however, displays features which determine its relationship to described species of *Harpes*.

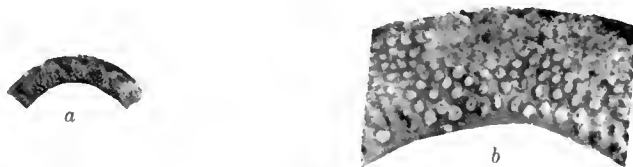


FIG. 112. *Harpes* sp. ind. F.M. No. P28697. *a*, Portion of a cephalic shield; natural size. *b*, Enlargement of a part of the same specimen.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes and Sharat K. Roy.

Order **Opisthoparia** Beecher

Family **Solenopleuridae** Angelin

Genus **Ischyrotoma** Raymond

This genus, with *Ischyrotoma twenhofeli* Raymond as genotype, was proposed by Raymond in 1925 (p. 54) for a small Opisthoparia "with short, highly convex cephalon, small eyes near the glabella, long, convex, oval glabella with no or inconspicuous lateral furrows, and steeply sloping cheeks which produce a strongly notched appearance at the front of the head."

Ischyrotoma(?) **raymondi** Roy, sp. nov.

Description.—Cranidium very small and strongly convex. Glabella longer than wide, rounded at the anterior end and sloping in level with but not overhanging the anterior border. Posterior end straight. Glabellar furrows, of which a pair is shown, are merely faint impressions. Both are directed backwards and are more or less parallel. Dorsal and occipital furrows deep, which make

the glabella conspicuous. Fixed cheeks steeply sloping. Eyes not preserved; they seem to have lain opposite the two glabellar furrows but not as close to the dorsal furrows as in the genotype. Surface of entire cranidium covered with small, unequal pustules.

Diagnosis.—This species differs from the only other described species, *Ischyrotoma twenhofeli* Raymond, in having a relatively wider and less overhanging glabella. The eyes are farther away from the dorsal furrows, and the posterior border of the fixed cheek is slightly curved forward or sinuous, but not rounded as in *I. twenhofeli*. Antero-posterior diameter of glabella 2.8 mm., width of the posterior end 2 mm.



FIG. 113. *Ischyrotoma(?) raymondi* Roy, sp. nov. F.M. No. P28698. Holotype. A damaged cranidium; $\times 4$.

Remarks.—*I. twenhofeli* from the upper Chazy(?) is represented by two specimens, one of which was collected from a pebble in Cow Head conglomerate at Lower Head, Newfoundland, and the other from a boulder in conglomerate, two miles north of Mystic, Quebec, Canada. The questionable reference of the present species to this genus is due to the damaged condition of the specimen and to the uncertainty regarding the exact position of the eyes. There is, however, no other genus in which it could be more appropriately placed.

This interesting specimen is named in honor of Dr. Percy E. Raymond, of Harvard University.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28698.

Family Remopleuridae Corda

Genus Remopleurides Portlock

Remopleurides sp.

Remarks.—This form in general resembles the Trenton species *Remopleurides striatulus* Walcott but differs in the following characters: (1) The buccal notch is wider and rounded; (2) the muscular scars are more kidney-shaped than oval and situated closer to each other; and (3) the elevated lines on the surface are less regularly disposed.

There is little doubt that the specimen under consideration represents a new species, but since it is only an incomplete hypostoma it cannot very well serve as a type.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.



FIG. 114. *Remopleurides* sp. F.M. No. P28699. $\times 6$.

Family *Asaphidae* Burmeister
 Subfamily *Asaphinae* Raymond
 Genus *Isotelus* DeKay

Isotelus gigas latior Roy, var. nov.

This variety is represented by a well-preserved hypostoma. The incomplete pygidium included here is of a different individual. It may or may not belong to this variety.



FIG. 115. *Isotelus gigas latior* Roy, var. nov. *a*, A hypostoma. F.M. No. P28700. Holotype. $\times 5/6$. *b*, A broken pygidium. F.M. No. P28700A. Natural size.

Diagnosis.—The wings of the hypostoma, for their length, are much wider and situated much farther apart than in *Isotelus gigas*, to which it is most closely related. The pygidium is broken and damaged but enough of it is preserved to indicate that it is a variant of *I. gigas* DeKay.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F. M. No. P28700.

Isotelus cf. *I. iowensis* (Owen)

Remarks.—This pygidium approaches *Isotelus iowensis* (Owen) from the Richmond of Iowa in general outline, shape of its axial lobe, and border, but, on account of its fragmentary nature, identification is not possible.

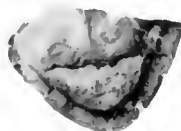


FIG. 116. *Isotelus* cf. *I. iowensis* (Owen). F.M. No. P28701. Natural size.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family *Illaenidae* Corda

Genus *Illaenus* Dalman

Illaenus baffinlandicus Roy, sp. nov.

Diagnosis.—The pygidium of this species shows close affinity to *Illaenus consimilis* Billings, *I. groenlandicus* Troedsson, and *I. americanus* (Billings). It

is, however, closer to *I. consimilis* than the other two, differing mainly in smaller size and in the proportion of its length to width, 2:3, compared to 1:2 in *I. consimilis*. The same proportional difference may also be applied to distinguish the present species from *I. groenlandicus*. From *I. americanus* it differs in having a more projected axis and less obliquely truncated anterior angles. The surface ornamentation of this pygidium is somewhat like that of *I. consimilis*, being marked with wavy, branching lines. This is not the case, however, with either *I. americanus*



FIG. 117. *Illaenus baffinlandicus* Roy, sp. nov. F.M. No. P28703. Holotype. *a*, An incomplete cranidium. *b*, A pygidium. Both $\times 1\frac{1}{2}$.

or *I. groenlandicus*. In the former the surface striae seem “to radiate irregularly from the axis as a centre” (Billings, 1865, p. 330), and in the latter “the striae cross the axis, curving more or less forward; from the axis they radiate over the pleural portion, sometimes being united by an additional line, which runs inside and parallel to the dorsal furrows.” (Troedsson, 1928, p. 36.)

Length of pygidium 16 mm., width 24 mm. Length of the axis 8.5 mm., width at the anterior extremity 9.2 mm.

Remarks.—The cranidium of this species is incomplete and in a very poor state of preservation. Only the glabella, which is wide (width at the posterior end 12 mm.) and bounded by almost parallel dorsal furrows like that of *I. consimilis*, can be described with any degree of certainty.

Horizon and locality.—Richmond. Silliman’s Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28703.

Illaenus punctatus Roy, sp. nov.

Diagnosis.—This species bears some resemblance to *Illaenus angusticollis* Billings and *I. groenlandicus* Troedsson, but can be distinguished readily from both. It differs from *I. angusticollis* in having wider and shorter glabella and in having its eyes situated closer to the posterior margin. From *I. groenlandicus* it differs in the following characters: Head less convex dorso-ventrally; glabella longer and much less convex; dorsal furrows longer and deeper but less wide, the course of the furrows almost similar to that of *I. angusticollis*—a gentle inward curve from the posterior margin and then an abrupt outward turn before fading out; eyes more widely separated; entire surface densely covered, in net-like fashion, with irregular punctae of varying size. The punctae are larger and more

irregular in the glabella than on any other part, but unlike that of *I. groenlandicus*, the glabella of the present species is entirely free from any elevated striae.

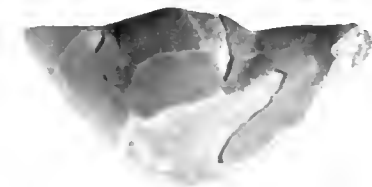
Antero-posterior diameter of cranium 17 mm. Width of glabella at the posterior margin 12.1 mm. Distance from the dorsal furrow to the eye 9 mm.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28704.

FIG. 118. *Illaenus punctatus* Roy, sp. nov. F.M. No. P28704. Holotype. A cranium; $\times 1\frac{1}{2}$.



Illaenus cf. *I. groenlandicus* Troedsson

Remarks.—There are four pygidia representing this form. All resemble Troedsson's figure (1928, pl. 13, fig. 18) of *Illaenus groenlandicus*, differing mainly

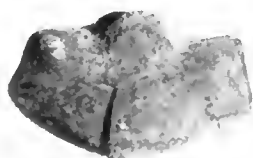


FIG. 119. *Illaenus* cf. *I. groenlandicus* Troedsson. F.M. No. P28705. Pygidia; $\times 3$ and $\times 2$, respectively.

in the proportion of length to width and in their convexities. No cranium has been found in association with these pygidia.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes and Sharat K. Roy.

Illaenus sp. ind.

Remarks.—This form is preserved as an internal mold of a portion of a cranium. The preserved portion, however, is not sufficient for adequate description or specific determination. Judging from the deep concavity of the mold it can be inferred that the cephalon is highly convex antero-posteriorly. Glabella short, about one-third of the length of the cephalon. Dorsal furrows short, deep, running first obliquely inward from the posterior margin, then turning abruptly outward and fading out within a distance of about 3 mm. Surface sparingly pitted.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

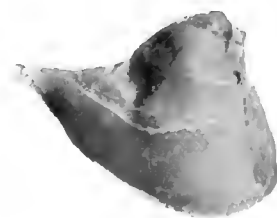


FIG. 120. *Illaenus* sp. ind. F.M. No. P28706. Internal mold of a portion of a cranium; natural size.

Genus **Bumastus** Murchison**Bumastus** sp. ind.

Remarks.—This genus is represented in the collection by a badly damaged head and a pygidium which is not complete, although rather well preserved. It is not known if the two are conspecific. The head is so badly damaged that specific identification is not possible. The pygidium resembles that of *Bumastus*



FIG. 121. *Bumastus* sp. ind. F.M. No. P28707. *a*, A damaged head; natural size. *b*, A pygidium; $\times 1\frac{2}{3}$.

aplatus Raymond from the lower Chazy of Vermont and Tennessee, but differs in having a more projected anterior border of the axial lobe, which is only faintly outlined. In the absence of better material, no attempt has been made at definite identification.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Order **Proparia** BeecherFamily **Encrinuridae** AngelinGenus **Encrinurus** Emmrich**Encrinurus** sp. ind.

Remarks.—There are two glabellae in the present collection. In general appearance both show a certain likeness to *Encrinurus rarus* (Walcott) from the Black River of Wisconsin, but the specimens are so badly damaged and so fragmentary that it has not been possible to make detailed comparison with that species. Both specimens, however, have retained just enough characters for generic diagnosis.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

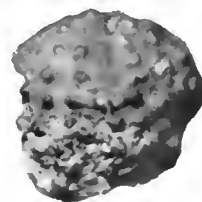


FIG. 122. *Encrinurus* sp. ind. F.M. No. P28708. A fragmentary glabella; $\times 6$.

Family **Calymenidae** Milne-EdwardsGenus **Calymene** Brongniart

Specimens of *Calymene* from the Ordovician, as has been pointed out by Raymond (1916, p. 27), "are difficult fossils to differentiate satisfactorily."

The reason seems to be that there are a number of similar forms whose characteristics are not sharply fixed or sufficiently constant for certain differentiation. An investigator trying to distinguish between two species often "feels" the differences but finds it most confusing and difficult to express them in words. I have met with these difficulties in attempting to decide whether the four cephalata upon which *Calymene croneisi* Roy, sp. nov. is based are really conspecific. The relative sizes of the glabellar lobes are not quite the same in all; the convexities of the cephalata vary, though not noticeably; and lastly, the amount of divergence of the dorsal furrows is by no means identical. These cephalata, therefore, are not exactly alike, yet it has not been possible to find any differences of sufficient significance to separate them.

According to Foerste (1919, p. 79), American Ordovician species of *Calymene*

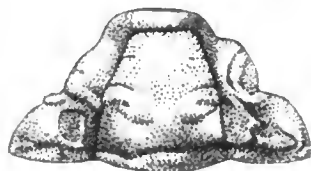


FIG. 123. *Calymene platycephala* Foerste.

"have the abbreviated form of glabella with the strongly divergent dorsal furrows," whereas the Silurian species "have the more elongate form of glabella, with the more moderately divergent dorsal furrows." Foerste's observation regarding the Silurian forms is fully in accord with the evidence at hand but the same cannot be said to apply to all species from the Ordovician. The form of the

glabella of *Calymene platycephala* Foerste (1910, pl. 2, fig. 7) from the Trenton of Tennessee, described by Foerste himself, can hardly be regarded as abbreviated nor can its dorsal furrows be called strongly divergent (fig. 123). The discovery of four cephalata of *Calymene croneisi* in Silliman's Fossil Mount, all having a decidedly elongate glabella with moderately divergent dorsal furrows, renders Foerste's statement regarding the glabellar characteristics of Ordovician Calymenes still more untenable. This is, however, only to be expected. To conceive of a sudden jump from an abbreviated Ordovician to an elongate Silurian form would not be in keeping with present conceptions of structural evolution and of speciation. Two such extremes are usually, if not always, connected by intermediate forms and it is the failure to find or to recognize intermediates, not their lack of existence, that sometimes leads to the formulation of such apparently erroneous hypotheses as "magnimutation."

Calymene croneisi Roy, sp. nov.

Diagnosis.—The cephalon of this species strongly resembles *Calymene senaria* Conrad, but it is a more slender and a more delicate form. Its chief distinguishing features are the following: Glabella more elongate; frontal lobe sloping more abruptly; preglabellar field more deeply excavated; front border between sutures of fixed cheeks more elevated and more strongly arched; and dorsal furrows less divergent, the portions bounding the second and third glabellar lobes being almost parallel.

The pygidium also, so far as it can be judged from the description and figures, is like that of *C. senaria*, differing only in minor details. The more salient features

of the pygidium of the present species are as follows: Subtrigonal, but the anterior margin rounded, imparting a more or less transversely suboval form to the general outline. Distinctly trilobed. Axis strongly convex; gently tapering; posterior extremity rounded; annulations eight, the last one not distinct. Ring furrows moderately deep and well defined anteriorly, becoming faint and obsolete posteriorly. Postaxial ridge short and turned up at the tip. Pleural lobes strongly deflected. Pleurae five or six, the last two not well defined, but all reaching (or nearly so) the margin, which is incurved. Rib furrows only slightly

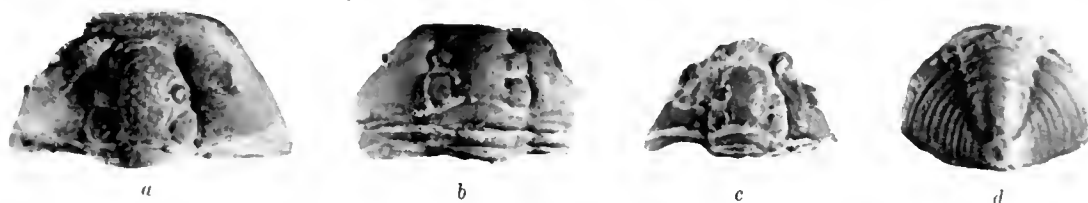


FIG. 124. *Calymene croneisi* Roy, sp. nov. *a, d*, Holotype. F.M. No. P28709. *a*, Cephalon; $\times 3$. *d*, Pygidium; $\times 4$. *b, c*, Cephalons. F.M. No. P28710. Paratypes; $\times 3$.

deeper than pleural furrows, all of which have their beginning at the axial furrow. Anterior bands of the pleurae wider than the posterior ones. Surface densely dotted with minute but unequal pustules.

The length of the best-preserved and the largest cephalon (holotype) is 7 mm., and of the glabella 4.5 mm. Width at the posterior margins of the facial sutures 12.2 mm. Width of the occipital ring 4.8 mm. Width between eyes 8 mm. Pygidium (holotype), length 3.5 mm., width 5 mm. Length of the axis 3 mm., width of the axis at the anterior end 2.1 mm.

Remarks.—There are four cephalons and two pygidia of this species in the collection. They were found independent of one another, but in adjacent slabs. The matrix and the nature of preservation of the specimens, however, are identical and it may, therefore, be safely assumed that they are parts of the same species.

The specific name is in honor of Dr. Carey Croneis, University of Chicago.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—Sharat K. Roy and John Jaynes.

Holotype.—F.M. No. P28709.

Calymene macmillani Roy, sp. nov.

Diagnosis.—In general, the pygidium of this species resembles that of *Calymene croneisi* Roy. The angle at the posterior extremity between the incurved lateral margins, however, is less acute. The axis is wider and less convex, its posterior end less rounded, almost straight. Annulations fewer, being only six and separated by deeper furrows. The pleural lobes are less abruptly

deflected, with fewer pleurae (five on each), none reaching the margins. The most noticeable distinguishing feature is the character of the pleural furrow, which is fainter and, unlike in *C. croneisi*, does not begin at the axial furrow but at some distance from it. The last pleura is coalesced with the posterior axial ridge, showing no impression of a pleural furrow. Surface of the pygidium smooth or sparsely pitted, a condition which may be due to mechanical abrasion. Length 4.5 mm., width 6 mm. Length of the axis 3.4 mm. Width of the axis at the anterior end 2.7 mm.



FIG. 125. *Calymene macmillani* Roy, sp. nov. F.M. No. P28711. Holotype. A pygidium; $\times 4\frac{1}{2}$.

Remarks.—The cephalon and thorax of this species are not known.

The specific name is in honor of Lieutenant Commander Donald B. MacMillan, Provincetown, Massachusetts.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28711.

Family Cheiruridae Salter

Subfamily Cheirurinae Raymond

Genus Ceraurus Green

Ceraurus cf. *C. horridus* Troedsson

Remarks.—This form is represented by a glabella and an occipital ring. Both are suggestive of *Ceraurus horridus* Troedsson, but neither is sufficiently well preserved for certain identification. *C. horridus* occurs in the Richmond portion of the Cape Calhoun beds at Cape Calhoun, Greenland. It has been adequately described by Troedsson (1928, pp. 65–67) and is an easily distinguishable species.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—John Jaynes.

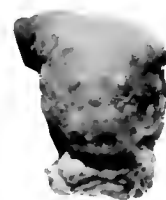


FIG. 126. *Ceraurus* cf. *C. horridus* Troedsson. F.M. No. P28712. An incomplete glabella; $\times 2$.

Ceraurus sp.

Remarks.—There are three caudal spines representing this genus. They resemble those of *Ceraurus tuberosus* Troedsson and may belong to that species.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

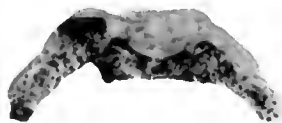


FIG. 127. *Ceraurus* sp. F.M. No. P28713. A caudal spine; $\times 4\frac{1}{4}$.

Ceraurinus icarus noduliferus Roy, var. nov.

Diagnosis.—The glabella agrees with the description of *Ceraurinus icarus* (Billings), differing in having a central node on the occipital ring.

Remarks.—A portion of the obtuse points of the backward curving extremities of the articulations of a pygidium is also present in this collection. It probably belongs to this variety. *Ceraurinus icarus* has been found in widely distributed areas, in Greenland, in the Island of Anticosti, in Manitoba, Iowa, Indiana, and Ohio, but is restricted to the Richmond.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28714.

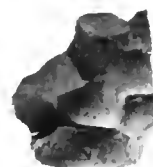


FIG. 128. *Ceraurinus icarus noduliferus* Roy, var. nov. F.M. No. P28714. Holotype. A glabella; $\times 2\frac{1}{3}$.

Family **Phacopidae** CordaSubfamily **Pterygometopinae** ReedGenus **Pterygometopus** Schmidt

Delo (1935, p. 417) has recently erected the genus *Calliops* for *Pterygometopus callicephalus* (Hall). It is questionable, however, if this species warrants generic separation.

In his discussion of *Calliops*, Delo states (p. 417): "The genus differs primarily from *Pterygometopus* s.s. as typified by *P. sclerops* (Dalman) in the less alate frontal lobe which slopes abruptly to the cephalic border. In *P. sclerops* the

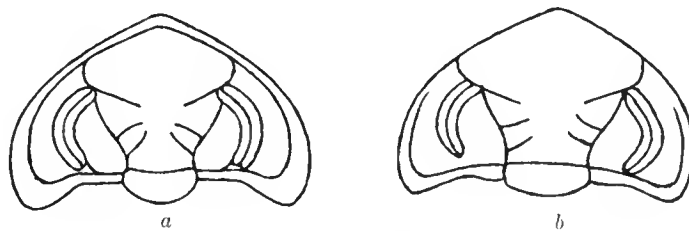


FIG. 129. a, *Pterygometopus callicephalus* (Hall). b, "*Pterygometopus callicephalus*," as shown by Delo (1935, fig. 42).

lateral lobes are more or less elliptical, grading downward in size backward, the first lobe much narrower than the frontal. In *Calliops*, by contrast, the first lateral lobes are very large, definitely triangular, and only slightly shorter than the frontal lobe"

The above reasons as basis for generic separation are not convincing. It may be true that the frontal lobe of *P. callicephalus* is less alate, but this can hardly be regarded as a generic character. The degree of alation of the frontal lobe of different species of *Pterygometopus* s.s. is variable. In regard to the abrupt sloping of the frontal lobe to the cephalic border in *P. callicephalus*, Delo's observation is not in accord with conditions in the type specimen of that

species. In fact, the line drawing given by him of *P. callicephalus* (1935, fig. 42; fig. 129, *b*, of this paper), showing the frontal lobe reaching the anterior margin, is not accurate. *P. callicephalus* has a narrower anterior border (see fig. 129, *a*),

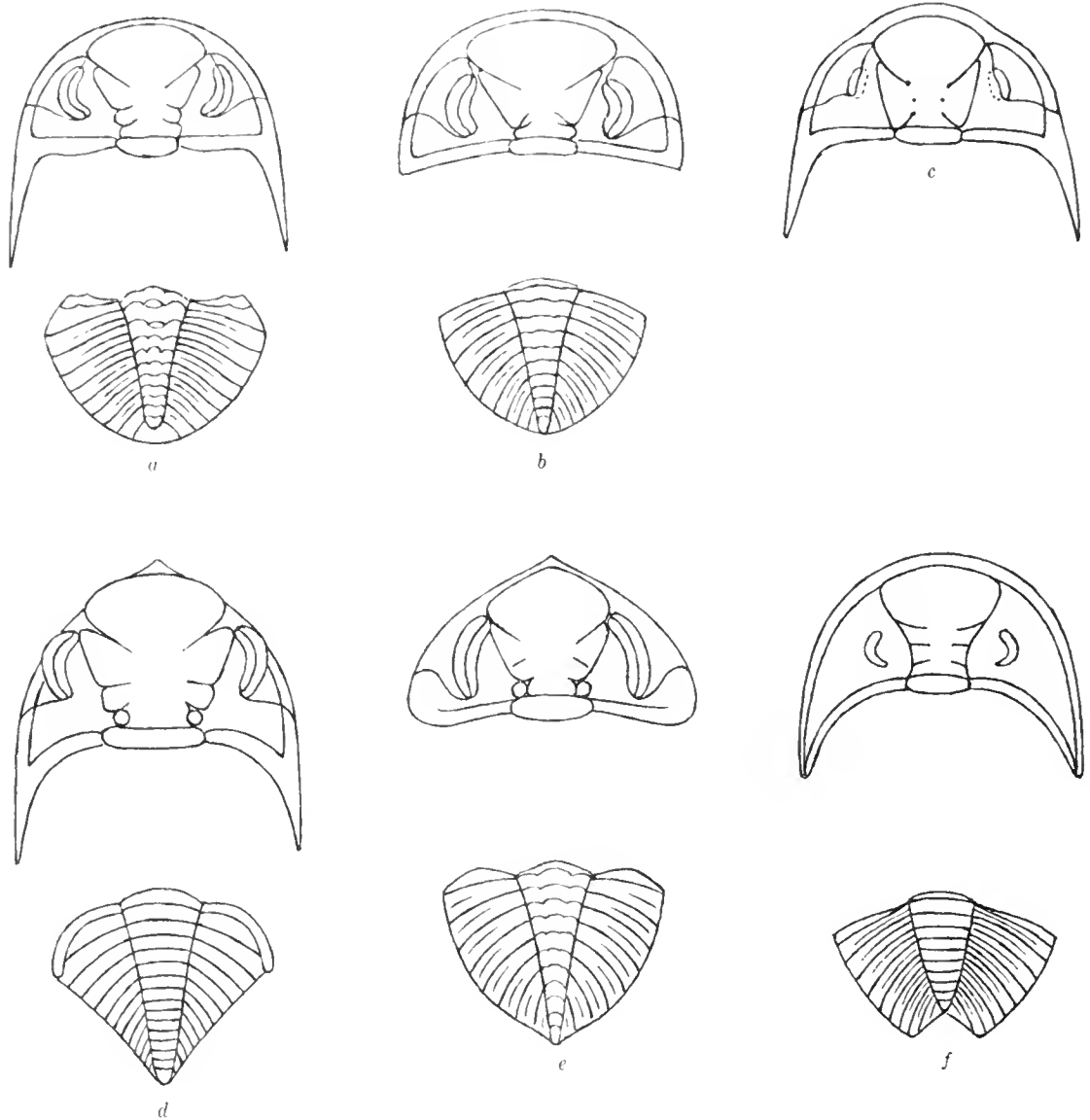


FIG. 130. Diagrams showing forms of different genera belonging to subfamily Pterygomotopinae. *a*, *Pterygomotopus*. *b*, *Chasmops*. *c*, *Monorakos*. *d*, *Eomonorachus*. *e*, *Calyptaulax*. *f*, *Achatella*.

and the frontal lobe is cut laterally by the facial suture characteristic of *Pterygomotopus*. Furthermore, it is not correct that the first lateral lobe of *P. callicephalus* is "only slightly shorter than the frontal lobe." Measurements of the first lateral and frontal lobes show that the former is less than one-half as large as the latter. Other distinguishing features mentioned by Delo are of lesser importance and need not be discussed here.

It is highly possible that all the species now placed in *Pterygometopus* s.s. are not congeneric and a more careful revision of that genus is needed. But until such revision¹ is made it would be inconsistent, if not confusing, to accept *P. callicephalus* as the type of a new genus. There are other species of *Pterygometopus* equally different, which could be placed for similar reasons in new genera. *P. schmidti* Clarke may be taken as an example. It is similar to *P. callicephalus*, differing mainly in the absence of genal spines. It could be separated from *P. sclerops* and referred to a new genus as readily as, if not more so (because of its genal spines) than *P. callicephalus*.

At present the following six genera (Fig. 130, a-f) belonging to the subfamily Pterygometopinae seem valid: *Pterygometopus* Schmidt, *Calyptaulax* Cooper, *Eomonorachus* Delo, *Chasmops* McCoy, *Monorakos* Schmidt, and *Achatella* Delo.

***Pterygometopus callicephalus brevis* Roy, var. nov.**

Diagnosis.—The cephalon of this variety is distinctly smaller and more convex than that of *Pterygometopus callicephalus* (Hall). The most noticeable



FIG. 131. *Pterygometopus callicephalus brevis* Roy, var. nov. F.M. No. P28715. Holotype. a, Cephalon. b, Pygidium. Both $\times 2$.

difference is its somewhat curved anterior furrows, which make the frontal lobe appear suboval. The glabella is more rapidly expanding, and the eyes are relatively larger.

The pygidium in all important features answers the description of *P. callicephalus* given by Clarke (1894, p. 731) and need not be redescribed here. Length of glabella including the neck ring 6.9 mm. Length of the frontal lobe 4 mm., width 5.8 mm. Length of eye 4 mm. Length of pygidium 7 mm., width (as preserved) 7.5 mm., length of axis 5.8 mm., width at anterior end 3 mm.

Remarks.—This variety is based on an incomplete cephalon and two pygidia. The cephalon and one of the two pygidia (F.M. No. P28715) probably belong to the same individual.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collectors.—John Jaynes and Sharat K. Roy.

Holotype.—F.M. No. P28715.

¹ It is hoped that when and if this revision is made the author will, as far as practicable, base his differentiations on actual specimens. Old original illustrations, particularly drawings, are frequently misleading and are often not sufficient for the determination of differential characters.

Pterygometopus sp. ind. I

Description.—Pygidium subtriangular; wider than long. Axis moderately convex, gently tapering, not reaching the posterior end. Pleural lobes slope gently near the dorsal furrows, and then abruptly. Annulations on both the axis and pleurae very faint, probably due to a film of calcareous incrustation. Pleurae do not reach the lateral margins, which are slightly elevated.



FIG. 132. *Pterygometopus* sp. ind. I. F.M. No. P28717. A pygidium; $\times 3\frac{1}{8}$.

Length 4.9 mm., width 6 mm. Length of the axis 3.7 mm.

Remarks.—This pygidium probably belongs to a young *Pterygometopus callicephalus* (Hall), but its poor state of preservation does not allow more accurate comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Pterygometopus sp. ind. II

Remarks.—This incomplete left pleural lobe shows eight pleurae, all of which are faintly grooved but none of which reaches the margins. The specimen is too fragmentary for identification.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.



FIG. 133. *Pterygometopus* sp. ind. II. F.M. No. P28718. A left pleural lobe of a pygidium; $\times 2\frac{1}{8}$.

Genus **Calyptaulax** Cooper

The genus *Calyptaulax* was proposed by Cooper in 1930 (p. 386) for a phacopid trilobite having generic relationships with certain American forms usually referred to *Pterygometopus*. Its chief generic character is "the coalescence of the first and second glabellar lobes, the second glabellar furrow being reduced to a faint impression, and the reduction of the third glabellar lobes to tubercles situated directly posterior to the coalesced lobes." The genotype is *Calyptaulax glabella* Cooper from the upper Ordovician at South Cove, Percé, Quebec, Canada. Cooper has described another species, *Calyptaulax compressa*, from the same locality and has placed the following American species in this genus: *Monorakos schucherti* Troedsson, *M. wimani* Troedsson, *Pterygometopus goodridgii* Schuchert, *P. eboraceus* Clarke, *P. lincolnensis* Branson, *P. confluens* Foerste and *P. holstonensis* Raymond.

According to Cooper *Calyptaulax* is restricted to American deposits (Cooper, 1930, p. 388), but Delo extends its occurrence to the British Isles (Delo, 1935, p. 416). The only British phacopid species that may belong to the genus is

Phacops brongniarti Portlock (Salter, 1864, p. 34, pl. 1, figs. 20-26). It is not certain, however, that it is a *Calyptaulax*. Of the nine figures given by Salter, only one (fig. 20, *a*, a drawing) shows the generic character of *Calyptaulax*, namely, the coalescence of the first and second glabellar lobes, since the second lateral furrows do not reach the dorsal furrow.

The British specimens are of Caradocian age, which is roughly equivalent to the Richmond of America.

Calyptaulax sillimani Roy, sp. nov.

Description.—Cephalon sub-semicircular with a central short projection at the anterior extremity. The general outline is not unlike that of *Calyptaulax goodridgii* (Schuchert). The glabella, however, is distinctive and unlike all other described species of the genus. The frontal lobe is large,

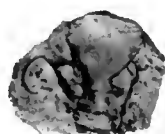


FIG. 134. *Calyptaulax sillimani* Roy, sp. nov. F.M. No. P28719. Holotype. Cast¹ of cephalon from natural mold; $\times 2$.

occupying more than one-half of the glabella. Its anterior portion is also very wide (5 mm.) but the width diminishes rapidly posteriorly, giving it the shape of an inverted triangle. The median portion between the first and second lobes is very narrow and convex, but widens suddenly and becomes less convex as it reaches the neck furrow. The first lobes are subpentagonal, the second subrectangular. The basal lobes are very small, their outer extremities merely isolated, small tubercles. The anterior glabellar furrows are directed obliquely forward and well defined,

but the second furrows are only short incisions at the inner extremities. This makes the first and second lobes coalesce along the dorsal furrows into one large subpentagonal lobe. Neck furrow narrow, but deeply grooved. Neck ring wide (1.5 mm.) and strongly convex. Palpebral lobes small; eyes large, extending from the anterior glabellar furrows to the neck furrow. The large size of the eyes renders both cheeks small. Marginal border wide but the width is not constant in its entire course. Genal angles produced into short spines like those of *Calyptaulax goodridgii*. Surface of cephalon smooth except the frontal lobe, which is granulated. Thorax and pygidium unknown.

Length on median line from the posterior to the anterior margins 8.2 mm. Width at points of the spines 12.8 mm. Length of the glabella 5.4 mm., width of the glabella at the anterior margin 5 mm., at the inner extremities of the first glabellar furrows 1.1 mm., and at the occipital furrow 2 mm.

Diagnosis.—*C. sillimani* can be readily distinguished from all other species of the genus by its elongate, subtriangular frontal lobe. Its very narrow and steep median portion between the first and second lobes and its wide marginal borders are other distinguishing features.

¹ Since the description was written the cast has unfortunately been mislaid. It has, therefore, been necessary to photograph an artificial cast taken from the natural mold. Because of defects in the mold this artificial cast does not show clearly all the features seen in the original cast.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28719.

Genus *Eomonorachus* Delo

This genus was proposed by Delo (1935, p. 417) to mark "a stage in the phylogenetic sequence within the Pterygometopinae between *Pterygometopus* s.s. and *Calyptaulax* Cooper. *Pterygometopus* has the second lateral furrows deeper distally, meeting the dorsal furrows at their level. In *Eomonorachus* the second lateral furrows are complete, but do not reach the dorsal furrows at their level, and are deepest at their mesial ends. A further change is noted in *Calyptaulax* in which the second lateral furrows are incomplete."

The genotype selected was *Pterygometopus intermedius* (Walcott) (see also Delo, 1935, p. 417) from the Black River. With the exception of the species described here the genotype is the only other known species of this genus.

Eomonorachus deloi Roy, sp. nov.

Description.—Sublunate in outline. Glabella large, depressed convex, rapidly enlarging anteriorly. Frontal lobe transversely suboval, rounded laterally and at the front; large, more than half as long as the glabella and bordered by a narrow margin which, unlike described species of *Pterygometopus*, is barely pointed at the anterior extremity. Anterior pair of glabellar furrows doubly curved like that of *Calyptaulax holstonensis* (Raymond); second pair shorter and directed obliquely backward; third pair still shorter and directed more obliquely than the second pair. First pair of lateral lobes subtriangular; second pair rectangular; third pair obscurely outlined. Median region depressed, becoming convex near the occipital furrow. Occipital ring moderately large, convex. Dorsal furrows well excavated. Palpebral lobes prominent. Surface densely tuberculate. Except for a few facets of the left eye, the other features of the cephalon are not preserved.

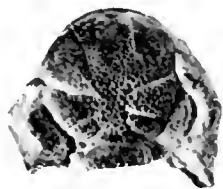


FIG. 135. *Eomonorachus deloi* Roy, sp. nov. F.M. No. P28720. Holotype. An incomplete cephalon; $\times 2\frac{1}{8}$.

Length on median line from posterior to anterior margins 9 mm. Length of the glabella excluding the neck ring 7.5 mm. Width at anterior lobes 7 mm.

Diagnosis.—The present species, though based on an incomplete cephalon, can be readily distinguished from the genotype by the suboval shape of its frontal lobe, by its doubly curved anterior lateral furrows and by the almost rounded anterior extremity of its marginal border.

Remarks.—The specific name is in honor of Dr. David M. Delo, of Knox College, Galesburg, Illinois.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28720.

Subclass **Eucrustacea** Kingsley

Superorder **Ostracoda** Latreille

Ostracods are not as plentiful in this collection as might be desired. Only eleven species of ostracods representing eight genera have been described here. Doubtless many more occur at the locality under consideration but because of their microscopic size they have escaped attention both in the field and in the laboratory.

Superfamily **Leperditacea**

Family **Leperditiidae** Jones

Genus **Leperditia** Rouault

Emended description (Bassler, 1934, p. 14).—"Shell suboblong with an oblique backward swing, usually large, commonly exceeding 8 mm. in length. Ventral edge thick, formed by the overlap of the right valve. Valves strongly unequal, the right the larger and widely overlapping the ventral edge of the left; hinge simple. A small tubercle, or 'eye-spot,' is generally present on the anterodorsal fourth, while a large, rounded, subcentrally situated muscular imprint is a well-marked feature of the interior and is sometimes distinguishable even on the exterior."

Genotype.—*Leperditia crittanica* Rouault.

Leperditia cf. **L. ulrichi** Troedsson

Leperditia ulrichi Troedsson, Medd. om Grønland, **72**, p. 80, pl. 19, figs. 24, 25, 1928.

Remarks.—Two right valves represent this form. Length and height of the larger one are 6.5 mm. and 4 mm. respectively; of the smaller one 4.9 mm. and



a



b

FIG. 136. *Leperditia* cf. *L. ulrichi* Troedsson. F.M. No. P28876. a, Right valve. b, Right valve of another individual. Both $\times 2$.

2.9 mm. respectively. Both valves agree closely in all essential features (straight hinge line, high shape, and maximum convexity on the center of the valves) with *Leperditia ulrichi* Troedsson except that they are a little more elongate.

L. ulrichi is from the Richmond of Cape Calhoun beds, Cape Calhoun, Greenland. According to Bassler (1934, p. 381) it is the same species as *Leperditia cabotensis* Ulrich and Bassler, from near Cabot Head, Ontario.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus *Isochilina* Jones

Emended description (Bassler, 1934, p. 14).—"Like *Leperditia* except that exteriorly the valves do not overlap but seem to be equal in every respect. In reality, within the left valve there is a sloping area that is overlapped by a corresponding leveled edge of the right valve. Surface sometimes lobulate or nodose."

Genotype.—*Isochilina ottawa* Jones.

Isochilina convexa Roy, sp. nov.

Three specimens represent this species.

Description.—Suboblong in outline with obliquely truncated posterior and anterior ends; rounded ventrally. Valves with strong convexity, like that of a broadly sloping low cone, the maximum convexity being at the center. Hinge

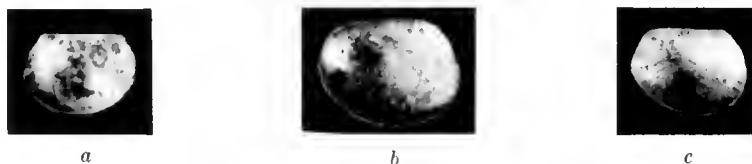


FIG. 137. *Isochilina convexa* Roy, sp. nov. F.M. No. P28877. *a*, Right valve; holotype. *b*, *c*, Two left valves. All $\times 3$. The three valves illustrated are from different individuals.

line straight, about two-thirds the greatest length of the shell. Surface, except for the eye-spot on the antero-dorsal third (2 mm. posterior to the anterior end and 1.5 mm. below the dorsal edge), smooth. The holotype (a right valve, fig. 137, *a*) is 5.1 mm. long and 3.9 mm. high. Of the two left valves, the larger one is 6.1 mm. long and 5 mm. high, the smaller one 5.2 mm. long and 4.1 mm. high.

Diagnosis.—The species approaches *Isochilina vaurealensis* Twenhofel from the Richmond of Vaureal Falls, Anticosti Island, but differs in its greater convexity, smooth surface, and more posteriorly placed antero-dorsal tubercle.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28877.

Family **Leperditellidae** Ulrich and BasslerGenus **Aparchites** Jones

Emended description (Bassler, 1934, p. 14).—"Shell not extending 3 mm. in length, equivalent, subovate or oblong; hinge straight, ventral edge thickened, often beveled or channeled; surface convex, mostly in the ventral half, smooth."

Genotype.—*Aparchites whiteavesi* Jones.

Aparchites(?) sp.

Description.—This form is represented by a single specimen damaged along the antero-ventral edge so that its exact outline can not be determined. Length 2.9 mm., height 2.4 mm., and width 1.9 mm. Left valve slightly pro-

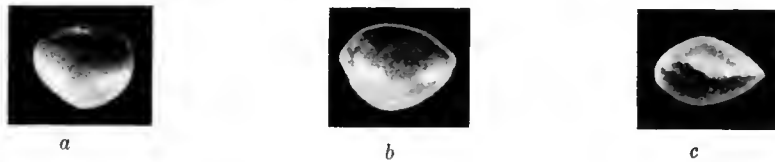


FIG. 138. *Aparchites(?)* sp. F.M. No. P28878. *a*, Right valve. *b*, Left valve. *c*, Dorsal edge. All $\times 5$.

truded over the right about the middle of the hinge line. Edges of the valves considerably thickened but apparently not overlapping. Surface convex (the convexity increasing toward the posterior region) and concentrically pitted. This concentric arrangement of the pits is best seen around the rounded subcentrally placed muscular imprint.

Diagnosis.—The questionable generic reference of this form is chiefly due to the fact that its surface is ornamented instead of being smooth, which is believed to be a diagnostic feature of the members of the family Leperditellidae. On the other hand, the specimen has protruding dorsal region and thickened edges, both of which are good determinative characters of the genus *Aparchites*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Superfamily **Beyrichiacea**Family **Primitiidae** Ulrich and BasslerSubfamily **Primitiinae**Genus **Primitia** Jones and Holl

Emended description (Bassler, 1934, p. 17).—"Distinguished from *Primitiella* by having a well-marked subcentral, usually curved sulcus with undefined swellings or low nodes on one or both sides of it instead of an undefined depression. As a rule also the valves are shorter, the outline being generally more ovate."

Genotype.—*Primitia mundula* Jones.

Primitia cincinnatiensis (Miller)

Primitia cincinnatiensis (Miller). See R. S. Bassler, Geol. Soc. Amer., Special Papers, **1**, p. 440, 1934, for references to literature and synonyms.

Remarks.—There are two specimens of this species, one of which is a slightly damaged right valve, the other a well-preserved left valve.



FIG. 139. *Primitia cincinnatiensis* (Miller). F.M. No. P28879. *a*, Right valve. *b*, Left valve. Both $\times 15$.

Primitia cincinnatiensis (Miller) occurs in the Richmond of various localities in Ohio, Indiana, and Michigan.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Genus Halliella

Emended description (Bassler, 1934, p. 17).—“Like *Euprimitia*, but with broader sulcus and very coarsely reticulate surface which rises to greatest height in antero-dorsal quarter. Thick double border.”

Genotype.—*Halliella retifera* Ulrich.

Halliella jaynesi Roy, sp. nov.

Description.—Valves broadly oval with a strongly convex body encircled by a narrow border which is convex except in the ventral portion where it is concave and upturned. Cardinal line nearly straight, much shorter than the



FIG. 140. *Halliella jaynesi* Roy, sp. nov. F.M. No. P28880. Holotype. *a*, Right valve. *b*, Left valve. *c*, Dorsal view. *d*, Ventral view. All $\times 4$.

greatest length of the shell. Anterior end a little narrower than the posterior end; both ends rounded. Edges of the valves thick, bevelled dorsally, lip-like ventrally. There is a trace of a sulcus in the central part of the upper half, and each valve has a slightly elevated rounded spot at the center. Surface marked by minute pustules among which are dispersed irregularly a few larger ones. Length 3.5 mm., height 2.9 mm., width 2 mm.

Diagnosis.—Of the two Ordovician species known of this genus—*Halliella sculptilis* (Ulrich) from the Trenton (Perryville) of Kentucky and *Halliella labiosa* Ulrich from the Trenton (Prosser) of Minnesota—the present species resembles the latter in general outline and in the thick lip-like ventral edge; otherwise it is so different that further comparisons are unnecessary.

Remarks.—The specific name is in honor of Mr. John Jaynes, who served as engineer in the expedition schooner, the *Bowdoin*.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28880.

Subfamily Eurychilinae Ulrich and Bassler

Genus *Eurychilina* Ulrich

Emended description (Bassler, 1934, p. 20).—“Oblong or semi-elliptical, long-hinged shells having a subcentral Primitian sulcus, the posterior edge of which is often raised into a small rounded node; free margins provided with a wide, usually radiately plicated, frill-like border curved on its under side so as to form a concave area around the true contact edge of the valves.”

Genotype.—*Eurychilina reticulata* Ulrich.

Eurychilina bassleri Roy, sp. nov.

This description is based on a nearly perfect left valve.

Description.—Semi-circular in outline. Body strongly convex, sloping abruptly toward the inner edge of the marginal area to form a depressed border from end to end. Cardinal line straight, about as long as the greatest width of the valve. Anterior and posterior ends approximately straight, curving inward ventrally. Sulcus subcentral, deep and wide, beginning within the dorsal margin and extending a little more than halfway across the body. Below the sulcus the surface is elevated, forming an obtuse ridge-like prominence which is terminated on its posterior side by a large, rounded node. Marginal area strongly convex and of nearly uniform width in the ventral region, becoming narrower as the dorsal angles at each end are approached. There is an indication that the border of the marginal area is reflexed. Surface irregularly pitted except around a line parallel to and a short distance below the inner edge of the marginal area where the pittings appear to be more or less uniformly arranged. Length 2.2 mm., height 1.5 mm.

Diagnosis.—This species is related to *Eurychilina manitobensis* Ulrich from the Richmond of Manitoba but differs in its greater convexity of the body and pitted surface.



FIG. 141. *Eurychilina bassleri* Roy, sp. nov. F.M. No. P28881. Holotype. Left valve; $\times 9$.

Remarks.—The specific name is in honor of Dr. R. S. Bassler, of the United States National Museum.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Holotype.—F.M. No. P28881.

Eurychilina sp.

Description.—This form is represented by a single external mold of a left valve. The specimen, however, is not well enough preserved for detailed description. It is 2 mm. long and 1.4 mm. high, semicircular in outline with a convex body. Cardinal line straight, a little shorter than the greatest width of the shell. Anterior and posterior ends almost straight, becoming rounded ventrally. Sulcus subcentral, with a prominent node behind it. Marginal area concave, with indications that it is frilled and that it has a narrow upturned outer edge. Surface pitted.

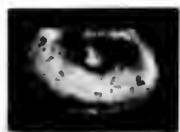


FIG. 142. *Eurychilina* sp. F.M. No. P28882. External mold of a left valve; $\times 9$.

Diagnosis.—The only member of the genus that resembles this species seems to be *Eurychilina frobisherii* (Emerson), but the illustrations (drawings) of that species are too poor for comparison.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Superfamily Cypridacea

Family Beecherellidae Ulrich

Genus *Krausella* Ulrich

Emended description (Bassler, 1934, p. 38).—"Similar to *Beecherella*, except that the valves are more unequal, the left overlapping the right both dorsally and ventrally, while but a single spine occurs, this being a prolongation of the posterior extremity of the smaller (right) valve."

Genotype.—*Krausella inaequalis* Ulrich.

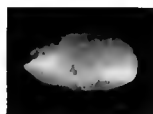
Krausella rawsoni Roy, sp. nov.

Description.—Subelliptical in outline. Both valves almost equally convex, left one a little larger, slightly overlapping the right all around except at its acuminate posterior extension. This extension, however, is very short, hardly perceptible with the unaided eye. Surface under high magnification appears marked with a few minute, thinly scattered pustules. Length 1.4 mm., height 0.6 mm.

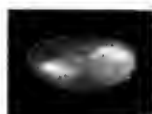
Remarks.—This species shows no close affinity to any described member of the genus from the Ordovician. Its almost equally convex valves and short

posterior extension of the right valve may alone serve as sufficient distinguishing characters.

The specific name is in honor of the late Frederick H. Rawson, sponsor of the expedition.



a



b

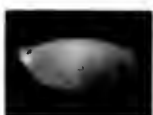
FIG. 143. *Krausella rawsoni* Roy, sp. nov. F.M. No. P28883. Holotype. *a*, Right valve. *b*, Left valve. Both $\times 11$.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

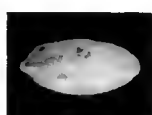
Holotype.—F.M. No. P28883.

***Krausella* cf. *K. inaequalis* Ulrich**

Remarks.—This form shows strong likeness to *Krausella inaequalis* Ulrich from the Black River (Plattville) of Illinois, except that it is a little more elongate



a



b

FIG. 144. *Krausella* cf. *K. inaequalis* Ulrich. F.M. No. P28884. *a*, Right valve. *b*, Side view of right and left valves, showing overlapping. Both $\times 7$.

and the shell is not so thick. Moreover, the left valve, though distinctly larger, does not overlap the right one as strongly. It may be a new species but inasmuch as there is only a single specimen for consideration and so many of its essential characters are similar to those of *K. inaequalis*, it can not be used as a type.

Length 2.3 mm., height 1.1 mm.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

***Krausella* sp.**

Description.—There are two valves, a right and a left, referable to this genus; they may or may not belong to the same individual. Left or larger valve well preserved; length 2.9 mm., height 1.9 mm. Subelliptical, thick, and convex. Dorsal margin gently curved, ventral margin more or less straight, anterior and posterior ends rounded, having similar outlines. Right valve damaged along postero-ventral edge; length 2.9 mm., height 1.4 mm. There is indication of its posterior extension but it is broken and its exact nature cannot be ascertained.

The left valve is unlike any described species of the genus but since the right valve is damaged and the two valves may not belong to the same individual it would hardly serve any useful purpose to attempt to give this form specific identification.



FIG. 145. *Krausella* sp. F.M. No. P28885. *a*, Right valve. *b*, Left valve. Both $\times 5$.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

Family Bairdiidae Lieneklaus

Genus *Bythocypris* Brady

Emended description (Bassler, 1934, p. 39).—"Shell smooth, reniform, ovate or elliptical; left valve larger than the right, overlapping it usually on both the dorsal and ventral margins; dorsal margin convex, the ventral edge straighter, sometimes slightly concave."

Genotype.—*Bythocypris reniformis* Brady.

Bythocypris aff. *B. cylindrica* (Hall)

Bythocypris cylindrica (Hall). See R. S. Bassler, Geol. Soc. Amer., Special Papers, 1, p. 226, 1934, for references to literature and synonyms.

Remarks.—This form agrees very closely with *Bythocypris cylindrica* (Hall) except that the central third of the ventral slope is more strongly hollowed out than is the case with *B. cylindrica*. This may be an individual variation or again



FIG. 146. *Bythocypris* aff. *B. cylindrica* (Hall). F.M. No. P28886. *a*, Right valve. *b*, Left valve. Both $\times 7$.

it may be a specific character. There is, however, only one specimen at hand, so that it is impossible to determine which of the two interpretations is applicable.

B. cylindrica has been reported from the Trenton to the Richmond.

Horizon and locality.—Richmond. Silliman's Fossil Mount, Frobisher Bay, Baffin Land.

Collector.—Sharat K. Roy.

SYNOPSIS OF FAUNA

GEOLOGIC RANGES OF NORTH AMERICAN AND GREENLAND SPECIES ALLIED TO THOSE FROM SILLIMAN'S FOSSIL MOUNT

*Indicates species of little or no correlation value

INCERTAE SEDIS

Species from Silliman's Fossil Mount	Allied Species	Black River	Trenton	Richmond
<i>Receptaculites</i> sp.	<i>R. arcticus</i> Etheridge			?
<i>Receptaculites</i> (?) <i>fieldi</i> , sp. nov.				
<i>Receptaculites</i> sp.				

CORALS

<i>Streptelasma</i> sp. I	<i>S. breve</i> W. and S. (?)	+*		
<i>Streptelasma</i> sp. II	<i>S. robustum amplum</i> Troedsson			+
<i>Streptelasma</i> sp. III	<i>S. corniculum</i> Hall		+*	
<i>Favistella</i> sp.	<i>Columnaria (Favistella)</i> <i>alveolata</i> Goldfuss			
<i>Plasmopora lambei</i> Schuchert				+
<i>Plasmopora pattersoni</i> , sp. nov.	<i>P. lambei</i> Schuchert			+
<i>Calapoecia canadensis</i> <i>anticostiensis</i> Billings				+
<i>Halysites agglomeratiformis</i> Whitfield				+
<i>Halysites</i> cf. <i>H. gracilis</i> (Hall)				+

CYSTOID and CRINOID

<i>Cheirocrinus</i> sp.				
<i>Carabocrinus</i> sp.				

BRYOZOANS

<i>Prasopora</i> sp.				
<i>Batostoma</i> sp.				
<i>Atactoporella</i> cf. <i>A. schucherti</i> Ulrich				+
<i>Dianulites</i> sp.	<i>D. petropolitanus</i> Dybowski		?	
<i>Eridotrypa bassleri</i> , sp. nov.	<i>E. simulatrix</i> (Ulrich)			+
<i>Eridotrypa</i> cf. <i>E. aedalis</i> <i>minor</i> (Ulrich)			+*	

BRACHIOPODS

Species from Silliman's Fossil Mount	Allied Species	Black River	Trenton	Richmond
<i>Plectorthis inaequiconvexa</i> , sp. nov.	<i>P. plicatella</i> (Hall)			?
	<i>P. plicatella trentonensis</i> Foerste		+*	
<i>Platystrophia magnisulcata</i> , sp. nov.	<i>P. elegantula triplicata</i> McEwan			?
<i>Skenidioides</i> (?) sp.				
<i>Hesperorthis interplicata</i> , sp. nov.	<i>Orthis tricenaria</i> Conrad	+*		
<i>Glyptorthis bellarugosa</i> (Conrad)		+*		
<i>Austinella cooperi</i> , sp. nov.	<i>A. scovillei</i> Miller			+
<i>Austinella</i> (?) <i>subcircularis</i> , sp. nov.	<i>A. kankakensis</i> (McChesney)			+
<i>Dalmanella diminutiva</i> , sp. nov.	<i>D. cf. D. testudinaria</i> (Dalman)		?	?
<i>Dalmanella sillimani</i> , sp. nov.	<i>D. rogata</i> (Sardeson)	+*	+*	
	<i>D. corpulenta</i> (Sardeson)			+
	<i>D. ignota</i> (Sardeson)			+
<i>Dolmanella</i> sp.				
<i>Parastrophinella hemiplicata minor</i> , var. nov.	<i>P. hemiplicata</i> (Hall)		+	+
<i>Rafinesquina pronis</i> , sp. nov.	<i>R. declivis</i> (James)		+*	
<i>Rafinesquina declivis subnutans</i> , var. nov.	<i>R. declivis</i> (James)		+*	
<i>Rafinesquina productiformis</i> , sp. nov.				
<i>Rafinesquina</i> sp.				
<i>Sowerbyella</i> sp.				
<i>Strophomena undulosa</i> , sp. nov.	<i>S. trilobata</i> (Owen)			+
<i>Strophomena</i> sp. I				
<i>Strophomena</i> sp. II				
<i>Rhynchotrema capax arcticum</i> , var. nov.	<i>R. capax</i> (Conrad)			+
<i>Rhynchotrema anticostiense breve</i> , var. nov.	<i>R. anticostiense</i> (Billings)			+
	<i>R. increbescens</i> (Hall)		+*	
<i>Rhynchotrema</i> sp.	<i>R. increbescens laticostatum</i> (Winchell and Schuchert)		+*	
	<i>Zygospira maynei</i> , sp. nov.	<i>Z. recurvirostris</i> (Hall)	+*	+*
<i>Cyclospira schucherti</i> , sp. nov.	<i>C. bisulcata</i> (Emmons)		+*	
<i>Cyclospira vokesi</i> , sp. nov.	<i>C. schucherti</i> , sp. nov.		+*	

PELECYPODS

<i>Ctenodonta baffinensis</i> Ulrich			?	
<i>Ctenodonta</i> cf. <i>C. subnasuta</i> Ulrich			+*	
<i>Ctenodonta ulrichi</i> , sp. nov.				

GASTROPODS

<i>Lophospira</i> cf. <i>L. augustina</i> <i>minnesotensis</i> Ulrich and Scofield			?	+
<i>Lophospira</i> sp. I				
<i>Lophospira</i> sp. II				
<i>Hormotoma rotundivolvis</i> , sp. nov.	<i>H.(?) major</i> (Hall)		?	+
<i>Hormotoma</i> sp. I				
<i>Hormotoma</i> sp. II				
<i>Hormotoma</i> sp. III				
<i>Eotomaria(?) robinsoni</i> , sp. nov.	<i>E. canolifera</i> Ulrich			
<i>Maclurina manitobensis(?)</i> (Whiteaves)				+
<i>Maclurina cuneata(?)</i> (Whitfield)				+
<i>Maclurites crassus(?)</i> (Ulrich & Scofield)				+
<i>Maclurites(?)</i> sp.				
<i>Trochonema</i> cf. <i>T. umbili-</i> <i>catum</i> (Hall)			+*	?
<i>Trochonema(?)</i> sp.				
<i>Holopea(?)</i> sp.				
<i>Hyalithes crowelli</i> , sp. nov.				

CEPHALOPODS

<i>Endoceras baffinense</i> Foerste				+
<i>Endoceras</i> sp. I	<i>E. fulgur</i> Billings			+
<i>Endoceras</i> sp. II				
<i>Endoceras</i> sp. III	<i>E. paliforme</i> Miller			+
	<i>E. manitobense</i> Foerste			+
<i>Endoceras</i> sp. IV				
<i>Ephippiorthoceras</i> sp. I				
<i>Ephippiorthoceras</i> sp. II				
<i>Charactoceras schucherti</i> Foerste	<i>C. plicatus</i> (Whiteaves)			+
	<i>C. rotundum</i> Troedsson			+

CEPHALOPODS—*continued*

Species from Silliman's Fossil Mount	Allied Species	Black River	Trenton	Richmond
<i>Actinoceras</i> sp.				
<i>Leurorthoceras(?) baffinense</i> Foerste				
<i>Kochoceras troedssoni</i> , sp. nov.	<i>K. cuneiforme</i> Troedsson <i>K. sublentiforme</i> Miller			+
<i>Kochoceras</i> sp.	<i>K. troedssoni</i> , sp. nov.			+
<i>Westenoceras greggi</i> , sp. nov.	<i>W. deckeri</i> Foerste			+
<i>Winnipegoceras laticurva-</i> <i>tum</i> (Whiteaves)				+
<i>Neumatoceras(?) tumidum</i> (Schuchert)				
<i>Cyrtogomphoceras baffinense</i> Foerste				+
<i>Cyrtogomphoceras furnishi</i> , sp. nov.				
<i>Cyrtogomphoceras</i> sp. I				
<i>Cyrtogomphoceras</i> sp. II				
<i>Diestoceras milleri</i> , sp. nov.	<i>D. magister</i> Foerste			+

TRILOBITES

<i>Harpes</i> sp. ind.				
<i>Ischyrotoma(?) raymondi</i> , sp. nov.				
<i>Remopleurides</i> sp.				
<i>Isotelus gigas latior</i> , var. nov.	<i>I. gigas</i> DeKay			
<i>Isotelus</i> cf. <i>I. iowensis</i> (Owen)				+
<i>Illaeus baffinlandicus</i> , sp. nov.	<i>I. consimilis</i> Billings			
	<i>I. groenlandicus</i> Troedsson			+
	<i>I. americanus</i> (Billings)		+	
<i>Illaeus punctatus</i> , sp. nov.	<i>I. angusticollis</i> Billings	+		
	<i>I. groenlandicus</i> Troedsson			+
<i>Illaeus</i> cf. <i>I. groenlandicus</i> Troedsson				+
<i>Illaeus</i> sp. ind.				
<i>Bumastus</i> sp. ind.				
<i>Encrinurus</i> sp. ind.	<i>E. rarus</i> (Walcott)	+		
<i>Calymene croneisi</i> , sp. nov.	<i>C. senaria</i> Conrad		+	
<i>Calymene macmillani</i> , sp. nov.	<i>C. croneisi</i> , sp. nov.			
<i>Ceraurus</i> cf. <i>C. horridus</i> Troedsson				+

TRILOBITES—*continued*

Species from Silliman's Fossil Mount	Allied Species	Black River	Trenton	Richmond
<i>Ceraurus</i> sp.				
<i>Ceraurinus icarus noduliferus</i> , var. nov.				+
<i>Pterygometopus callicephalus brevis</i> , var. nov.			+*	
<i>Pterygometopus</i> sp. ind. I				
<i>Pterygometopus</i> sp. ind. II				
<i>Calyptraulax sillimani</i> , sp. nov.				
<i>Eomonorachus deloi</i> , sp. nov.				

OSTRACODS

<i>Leperditia</i> cf. <i>L. ulrichi</i> Troedsson				+
<i>Isochilina convexa</i> , sp. nov.	<i>I. vaurealensis</i> Twenhofel			+
<i>Aparchites</i> (?) sp.				
<i>Primitia cincinnatiensis</i> (Miller)				+
<i>Halliella jaynesi</i> , sp. nov.	<i>H. labiosa</i> Ulrich		+	
<i>Eurychilina bassleri</i> , sp. nov.	<i>E. manitobensis</i> Ulrich			+
<i>Eurychilina</i> sp.				
<i>Krausella rawsoni</i> , sp. nov.				
<i>Krausella</i> cf. <i>K. inaequalis</i> Ulrich		+*		
<i>Krausella</i> sp.				
<i>Bythocypris</i> aff. <i>B. cylindrica</i> (Hall)			+*	+

PREVIOUS COLLECTIONS FROM SILLIMAN'S FOSSIL MOUNT

As referred to on page 44, three other collections besides the present one were made previously at Silliman's Fossil Mount. The first collection was made by Charles F. Hall during 1861-62. It was composed of two lots, of which one was collected from Silliman's Fossil Mount, the other from drift material on the northeast shore of Frobisher Bay and neighboring regions. The former was presented to the New York Lyceum of Natural History and the latter to Amherst College. The specimens from Silliman's Fossil Mount, consisting of seven species, were identified by R. P. Stevens (1863, p. 293) as follows: *Maclurea magna* (Lesueur), *Endoceras proteiforme*(?) (Hall), *Orthoceras*, *Heliolites* (sp. nov.), *Heliopora* (sp. nov.), *Halysites catenulata* (Fischer)(?), *Receptaculites* (sp. nov.).

None of these fossils was described or illustrated by Stevens, nor could they now be found for examination. It is, therefore, impossible to verify the accuracy of the identifications. As to the geological horizon indicated by these fossils, Stevens remarked (1863, p. 294):

"The fossils, without doubt, are all Lower Silurian. The *Maclurea magna* would place the limestone containing it on the horizon of the Chazy limestone of New York. The *Halysites catenulata* has been found in Canada in the Trenton beds, but in New York not lower than the Niagara limestone. The *Endoceras proteiforme* belongs to the Trenton limestone. The *Receptaculites* is unlike the several species of the Galena limestone of the West, or the *R. occidentalis* of Canada. Mr. Salter speaks of one found in the northern part of the American continent. This may be that species, or it may be a new one; which it was, we have no means of determining. The *Orthocerata* were but fragments, and so badly water-worn that the species could not be identified.

"The specimens of corals were very perfect and beautiful, and unlike any figured by Prof. Hall in the Paleontology of New York. The *Heliolites* and *Heliopora* belong to the Niagara group, in New York, but in Canada they have been found in the Lower Silurian. For the identification of strata, corals are not always reliable. Whether these species are similar or identical with any in the Canadian collection, it was out of my power to determine. They are unlike any figured by Mr. I. W. Salter."

It is apparent from the above statement that no particular horizon was determined other than that it was Lower Silurian. In fact it is scarcely possible to make any definite determination on the basis of such an inadequate collection.

The drift fossils that were given to Amherst College were identified and described by B. K. Emerson (1879, pp. 575-583). They were later restudied by Schuchert (1914, pp. 470-471) and Bassler (1911, pp. 32-36). The result of the restudy is here quoted from Schuchert's paper (1914, pp. 470-471).

Three general horizons can be made out in southern Baffin Island, as follows:

1. ORDOVICIAN. Dense gray to cream colored or whitish limestones, in some places approaching lithographic stone. In other places or other horizons the material is a fine-grained, light pinkish, magnesian limestone, but in general the color of all these limestones is the opposite of dark. As a rule fossils are absent in them. In the purer and less dense limestones very small fossils occur, chiefly Ostracoda. The latter were first identified by Professor Emerson, and have been recently restudied by Doctor R. S. Bassler, with the following results:

Leperditia canadensis Jones } These two species seem to Bassler to be other forms
Primitia muta Jones. } than those indicated by Emerson.

Primitia frobisherii Emerson = *Eurychilina frobisherii*.

Beyrichia symmetrica Emerson = *Drepanella symmetrica* (related to the Richmondian *B. richardsoni*).

Krausella cf. *anticostiensis* Jones. . . } Identified by Bassler.
Macrocypris cf. *subcylindrica* Jones }

Other associated fossils are a small *Scenidium*, sp. undet. (= *Rhynchonella* Emerson, p. 578), a small *Plectambonites*, sp. undet. (= *Chonetes* cf. *striatella*, p. 578), and fragments of undeterminable trilobites (= Emerson's *Phacops* and *Asaphus*).

The fine-grained, light pink, magnesian limestone from Hall's Island has minute crystalline cavities that Emerson thought might be casts of *Tentaculites*. These the writer could not make out to be due to organisms. Other undeterminable fossils are *Buthotrephis* (p. 575, fig. 1) and *Stictopora ramosa*(?) (p. 577, may be burrows).

On the basis of the Ostracoda, the only reliable fossils present, the horizon appears to be of Richmondian time, a formation of very wide distribution in North America. Bassler thinks the horizon and faunal realm represented are those of the English Head formation so well developed on the Island of Anticosti, Gulf of St. Lawrence.

2. ORDOVICIAN. Black, impure, thin-bedded, fine-grained limestones and black limy shales that weather yellowish white, with scattered small fossils as follows:

Climacograptus bicornis (Hall). Common at French Head in Cyrus Field Bay and in Fox Land on western Baffin Island. (Also called *Diplograptus dentatus* by Emerson, p. 576.)

Leptobolus lepis Hall (= *Lingula curta*, p. 578).

Cyclora parvula (Hall) (= *Cyclonema bilix*, p. 578).

"*Endoceras proteiforme* Hall" (p. 579). Not seen by the writer.

"*Orthoceras laqueatum*?" (p. 579). Too poor and fragmentary to make out even the genus.

Conularia trentonensis Hall (p. 578). A small fragment of a *Conularia* is present.

Triarthrus beckii Green. Common in fragments. It is probable that the Collingwood *T. magnificus* Twenhofel is also present (the tails are labeled *Calymene senaria* by Emerson, p. 582).

Cyphaspis(?) *frobisherii* Emerson (p. 583, fig. 11). Based on a free cheek; the genus is not determinable.

Ampyx(?) (Emerson's trilobite sp., p. 583, fig. 10).

Leperditia alta (Conrad). This is not Conrad's Silurian species but appears to be a new form of *Leperditia*.

This horizon, on the basis of the above fossils and the further fact that *Basilicus canadensis* (= *Asaphus canadensis* Chapman) occurs not far to the south at Cape Chidley, Labrador, seems to correlate with the Collingwood formation of Ontario. The same black shale is also present at Countess Warwick Sound, Blunt Peninsula, and probably as well at the head of Frobisher Bay.

3. SILURIAN. Gray, fine-grained dolomites of Rescue Harbor, Cyrus Field Bay, have *Orthis* cf. *davidsoni*, *Halysites catenularia*, and a pentamerid, probably the same as the next species. Farther west in Frobisher Bay in the identical dolomite occurs *Conchidium nysius tenuicostatum* (Hall), a form first described from the Falls of the Ohio. The *Cyathophyllum pickthorni* identified by Emerson (p. 577) are too poor to determine.

This horizon is well up in the Silurian, probably in the lower Lockport, and about the horizon of the Louisville as developed at Louisville, Kentucky.

Of these fossils only the first group, consisting mostly of ostracods which Schuchert believes to represent the Richmondian time, may have come from Silliman's Fossil Mount. At least they show a very close relationship with the ostracods described in this paper. The other two which, according to Schuchert, are the equivalent of the Collingwood (middle Ordovician) of Ontario and of the Louisville (Niagaran) as developed at Louisville, Kentucky, have apparently come from other sources and may not be considered here.

The second collection, consisting of twenty-six specimens, was brought to this country by Mr. G. Cromer of Boston in 1896. The specimens were believed to have been collected by the Eskimos at the head of Frobisher Bay (Silliman's Fossil Mount) but the circumstances under which Mr. Cromer secured them are not known. Dr. R. P. Whitfield, to whom the specimens were entrusted, found fourteen species among them. They are as follows (Whitfield, 1900, p. 21):

Small <i>Zaphrentis</i> or <i>Streptelasma</i> , sp.(?)	<i>Murchisonia</i> (<i>Lophospira</i>) <i>tricarinata</i> Hall, sp.
<i>Orthis</i> (<i>Dalmanella</i>) <i>testudinaria</i> Dalman, sp.	= <i>M. milleri</i> Hall
<i>Orthis</i> (<i>Plectorthis</i>) <i>jamesi</i> Hall	<i>Helicotoma planulata</i> , or an undescribed sp.
<i>Cyclospira bisulcata</i> Emmons, sp.	<i>Bellerophon</i> , sp. undescribed, nearest to <i>B.</i>
<i>Strophomena planumbona</i> Hall	<i>lindsleyi</i> Safford
<i>Cyclospira</i> , undescribed sp., plicated	<i>Oncoceras plebium</i> Hall
<i>Rhynchonella increbescens</i> Hall, not <i>R. capax</i>	<i>Trochoceras</i> , sp. undet.
Conrad	<i>Trocholites</i> , sp. undet.
<i>Tellinomya alta</i> Hall	

As to the stratigraphical conclusion, Whitfield stated (1900, pp. 21-22): "The geological horizon indicated by the group of specimens would be lower Trenton. The specimens are from calcareous clay and are finely weathered, indicating a locality where fine collections of fossils might be obtained with little trouble. The specimens have been collected from the surface and are mostly of small size and imperfect, so much so that those representing undescribed forms are too poor for description and illustration, though sufficient to determine the geological position."

The above specimens are now lost; at least all efforts to locate them have failed. It appears, however, almost certain (to judge from the characteristics of

the specimens) that they were collected from Silliman's Fossil Mount, but that they represent the lower Trenton is not in agreement with the studies made on the Ordovician in comparatively recent times. Apparently Whitfield based his conclusion on the similarity of the fauna to the Trenton (a method not infrequently practiced in his time), rather than on close, specific identification. But inasmuch as the specimens are not available it will serve little purpose to further discuss the subject.

The third collection, which is by far the largest and most important of all previous collections made at Silliman's Fossil Mount, was collected in 1897 by five members (Messrs. J. N. Carpender, R. W. Porter, A. V. Shaw, A. H. White and F. G. Goodridge) of the Seventh Peary Arctic Expedition. The entire collection, the greater part¹ of which is now in the collections of the United States National Museum, was placed at the disposal of Dr. Charles Schuchert for study. The results of his studies were afterwards published (Schuchert, 1900). He described seventy-one species, of which sixty-five were named specifically. They are:

- | | |
|--|--|
| <i>Receptaculites oweni</i> Hall = <i>Receptaculites arcticus</i> Etheridge? | <i>Ctenodonta baffinensis</i> , sp. nov. |
| <i>Ischadites iowaensis</i> (Owen) | <i>Modiolodon arctica</i> , sp. nov. |
| <i>Halysites catenulatus gracilis</i> (Hall) | <i>Whiteavesia symmetricus</i> , sp. nov. |
| <i>Lyellia affinis</i> (Billings) | <i>Cyrtodonta sillimanensis</i> , sp. nov. |
| <i>Plasmopora lambii</i> , sp. nov. = (in part) <i>Plasmopora pattersoni</i> Roy | <i>Cyrtodonta gibbera</i> Ulrich, var. |
| <i>Calapoecia canadensis</i> Billings | <i>Vanuxemia abrupta</i> Ulrich |
| <i>Streptelasma corniculum</i> Hall | <i>Vanuxemia baffinensis</i> , sp. nov. |
| <i>Porocrinus shawi</i> , sp. nov. | <i>Whitella arcticus</i> , sp. nov. |
| <i>Lichenocrinus affinis</i> Miller | <i>Saffordia modesta</i> Ulrich |
| <i>Crepipora</i> , sp. undet. | <i>Protowarthia pervolutus</i> Ulrich and Scofield |
| <i>Orthis tricenaria</i> Conrad = <i>Hesperorthis interplicata</i> Roy | <i>Tetranota obsoleta</i> Ulrich and Scofield |
| <i>Orthis (Dalmanella) testudinaria</i> (Dalman) = <i>Dalmanella sillimani</i> Roy | <i>Kokenia costalis</i> Ulrich and Scofield |
| <i>Orthis (Plectorthis) plicatella</i> Hall = <i>Austinella cooperi</i> Roy | <i>Bellerophon similis</i> Ulrich and Scofield |
| <i>Orthis (Hebertella) borealis</i> (Billings) = <i>Plectorthis inaequiconvexa</i> Roy | <i>Lophospira spironema</i> Ulrich and Scofield |
| <i>Orthis (Hebertella) bellarugosa</i> (Conrad) | <i>Liospira americana</i> (Billings) |
| <i>Orthis (Dinorthis) meedsi</i> Winchell and Schuchert | <i>Clathrospira conica</i> Ulrich and Scofield = (in part) <i>Eotomaria(?) robinsoni</i> Roy |
| <i>Orthis (Dinorthis) meedsi arctica</i> , var. nov. | <i>Seelya(?) ulrichi</i> , sp. nov. |
| <i>Platystrophia biforata</i> (Schlotheim) = <i>Platystrophia magnisulcata</i> Roy | <i>Helicotoma(?) larrata</i> Salter |
| <i>Parastrophia hemiplicata</i> Hall = <i>Parastrophia hemiplicata minor</i> Roy | <i>Maclurina manitobensis</i> (Whiteaves) |
| <i>Rhynchotrema inaequivalvis</i> (Castelnau) | <i>Maclurina cuneata</i> (Whitfield) |
| <i>Ctenodonta subnasuta</i> Ulrich? | <i>Maclurea crassa</i> Ulrich and Scofield |
| <i>Ctenodonta frobisherensis</i> , sp. nov. | <i>Trochonema umbilicatum</i> (Hall) |
| <i>Ctenodonta carpenderi</i> , sp. nov. | <i>Trochonema (Eunema) robbinsi</i> Ulrich and Scofield |
| | <i>Holopea arctica</i> , sp. nov. |
| | <i>Trochus(?)</i> , sp. undet. |
| | <i>Fusispira inflata</i> (Meek and Worthen) |
| | <i>Fusispira nobilis</i> Ulrich and Scofield |
| | <i>Cameroceas proteiforme</i> (Hall) = <i>Endoceras baffinense</i> Foerste |

¹ The remainder of the collection is in the American Museum of Natural History.

<i>Orthoceras olorus baffinensis</i> , var. nov.= <i>Spyroceras baffinense</i> (Schuchert)	<i>Oncoceras arcticum</i> , sp. nov.= <i>Beloitoceras arcticum</i> (Schuchert)
<i>Orthoceras bilineatum</i> Hall	<i>Poterioceras</i> , sp. undet.= <i>Diestoceras schucherti</i> Foerste
<i>Orthoceras porteri</i> , sp. nov.= <i>Spyroceras porteri</i> (Schuchert)	<i>Eurystomites plicatus</i> Whiteaves= <i>Characteroceras schucherti</i> Foerste
<i>Orthoceras scalariformis</i> , sp. nov.= <i>Kionoceras scalariforme</i> (Schuchert)	<i>Bythocypris granti</i> Ulrich
<i>Cyrtoceras manitobense</i> Whiteaves= <i>Thuleoceras ornatum</i> Troedsson	<i>Primitia</i> or <i>Kloedenia</i>
<i>Cyrtoceras cornulum</i> , sp. nov.= <i>Beloitoceras</i> (?) <i>cornulum</i> (Schuchert)	<i>Krausella</i> , two new species
<i>Cyrtoceras baffinensis</i> , sp. nov.= <i>Beloitoceras baffinense</i> (Schuchert)	<i>Nileus vigilans</i> (Meek and Worthen)
<i>Clinoceras exiguum</i> (Billings)	<i>Illaenus crassicauda americanus</i> (Billings)
	<i>Isotelus gigas</i> DeKay
	<i>Dalmanites</i> (<i>Pterygometopus</i>) <i>goodridgi</i> , sp. nov.
	<i>Ceraurus pleurexanthemus</i> Green

Based on the studies of the above fauna Schuchert concluded (1900, p. 152): "The foregoing list shows that at present there are 72 [71] species known from this locality, and of these 28 are restricted to it. There are, therefore, 54 species which are common to other localities, a goodly number with which to make safe correlations. Of these 54 species, 41, or 57 per cent of the known fauna, are also found in the region of Minnesota, Wisconsin, and Iowa, while 17 are known to occur in New York and Ottawa.

"On comparing the 54 widely distributed species with those from definite stages in Minnesota, it is seen that 10 are also found in Birdseye (=Lowville), 17 in the Black River, 38, or about 70 per cent, in the Galena, the direct equivalent of the New York Trenton, and 11 in the Cincinnati group.

"From these figures it is evident that the stage of Silliman's Fossil Mount belongs in the Galena, and that the fauna is more intimately related to that of the Minnesota region than to the Trenton of New York. When the New York Trenton fauna is restudied in the light of recent researches in Minnesota, however, it will be shown that the two faunas have more in common than now appears. On the other hand, the lithological similarities of the Minnesota Galena and Silliman's Fossil Mount—light-colored shales predominating in both areas—may explain in large measure the close identity of these widely separated faunas."

With regard to the general distribution of the fauna and to the presence of certain genera of corals which are definitely of younger age than the Trenton, Schuchert stated (1900, p. 175): "The Baffin Land fauna had an early introduction of Upper Silurian genera in the corals *Halysites*, *Lyellia*, and *Plasmopora*. In Manitoba similar conditions occur in the presence of *Halysites*, *Favosites*, and *Diphyphyllum*. Other Upper Silurian types do not appear to be present . . .

"The Trenton fauna of Baffin Land shows that the corals, brachiopods, gastropods, and trilobites have wide distribution, and are therefore less sensitive to the differing habitats apt to occur in widely separated regions. On the other hand, the cephalopods, and particularly the pelecypods, indicate a shorter geographical range. The almost complete absence of Bryozoa in the Baffin Land

Trenton contrasts strongly with the great development of these animals in Minnesota and elsewhere in the United States."

In 1911 Dr. R. S. Bassler restudied the fauna and came to the following conclusions (1911, pp. 34-36):

"(1) It is improbable that *Utica strata* occur in the far north, since the only fossil noted of any value in making such a correlation is *Triarthrus becki*, which is now known to occur also in the oldest Trenton. Of course it is possible that an arm of the sea extended northward during *Utica* time and allowed the deposition of these particular strata.

"(2) The Trenton age of the principal Ordovician deposits was determined by Schuchert by the percentage composition method. He found that of the 72 species known from the Silliman's Mount locality, 54 were common to other areas. Comparing these 54 with known horizons in Minnesota, it was found that 10 occur in the Lowville, 17 in the Black River, 38, or about 70 per cent, in the Trenton, and 11 in the Cincinnati. This prevalence of Trenton species seemed to be a good indication of the presence of a single fauna of that particular age. However, this method of correlation is open to some objections and has often been the occasion of error. In this particular example, the fossils were derived from the debris of a considerable thickness of strata, and there is just as much if not more reason for believing that the Lowville, Black River, Trenton and Richmond rocks are actually present in the section as for assuming that only Trenton strata occur. The former view is strengthened by the unquestioned stratigraphy of areas further south and west. Ulrich's identification of recent collections made by Kindle in Alaska, has shown the occurrence of a Black River fauna followed by a coral fauna of Richmond age. In Manitoba and elsewhere in Canada, the early Trenton strata (*Maclurea* bed) are succeeded by the Earliest Silurian Richmond group. The same succession of Richmond strata upon Trenton or older rocks is present in various parts of the Rocky Mountain area of the United States, especially in the Big Horn Mountains, and even as far south as El Paso, Texas. The most prevalent zone of the Richmond group contains numerous corals of Silurian genera, *Halysites*, *Lyellia*, *Plasmopora*, and *Calapoecia*. This is the same fauna noted on other pages of this work as present in the upper Lyckholm and Borkholm limestone of Baltic Russia. The 11 'Cincinnati' species recorded by Schuchert from Silliman's Mount includes this same coral fauna, and it therefore seems certain that the Richmond group is represented in the section. The Richmond age of these corals was further evidenced by the fact that two very characteristic brachiopods, a variety of *Platystrophia acutilirata* and of *Plectambonites sericeus* came to light when I carefully searched a fragment of limestone adhering to one of the corals. This particular variety of *Plectambonites* is highly characteristic of the Richmond in America and Europe. It is distinguished by the occurrence of small teeth along the edge of the cardinal area of the dorsal valve.

"The 38 strictly Trenton species, when compared with Minnesota faunas, are found to be characteristic of the *Clitambonites*, *Nematopora*, and *Maclurea*

beds of the Minnesota-Iowa composite section, or, in other words, probably occur in strata equivalent to the early Trenton (Stewartville and Prosser limestone) of the more southern area. The species of *Fusispira*, *Maclurea*, *Maclurina*, *Receptaculites*, *Ischadites*, and other genera listed by Schuchert as occurring in the Silliman's Mount fauna, and elsewhere only in the Minnesota Trenton, are associated with a gray, fine grained rock which, when carefully prepared, furnished a small fauna of Ostracoda including a *Leperditia* with Trenton affinities, but more especially the two bryozoans characteristic of the Nematopora bed in Minnesota, *Nematopora ovalis* Ulrich and *Pachydictya pumila* Ulrich.

"Concerning the occurrence of Lowville limestone at Silliman's Fossil Mount, the evidence is not as conclusive as that for the Lower Trenton and Richmond divisions, indeed, it is probable that only the equivalent of the Decorah shale is present since the 10 Lowville species listed by Schuchert occur also in that formation. Schuchert's list, however, shows enough characteristic Black River species to make it certain that some part of this group is represented in the section. Many of the specimens of these particular species show a slight difference in color and preservation from the Trenton forms discussed above. The more recent study of this Baffin Land fauna disclosed the presence of at least six species of Bryozoa, so that the remarks above concerning the practical absence of these forms are less to the point. Indeed, it is believed that the bryozoans are present, but because of their uninteresting aspect to the usual student, were not collected.

"Summing up, it seems probable from Schuchert's results, combined with the more detailed correlations of the present paper, that the geologic section at Baffin Land consists of Black River strata resting upon the old crystalline rocks, followed by an early Trenton formation equivalent to the Stewartville and Prosser limestones of Minnesota, and this in turn succeeded unconformably by the widespread coral zone of the Richmond group."

Schuchert agreed with Bassler's interpretation and said (1914, p. 472): "In conclusion, the writer agrees with Bassler that there are at least two Ordovician horizons represented at Silliman's Fossil Mount, namely, (1) a lower one containing the bulk of the fauna and equivalent to the Lower Trenton of Minnesota, and (2) an upper fauna here essentially made up of corals and the equivalent of that of Middle Richmond time. It is probable that the Black River equivalent is also present at the Mount, though less well exposed and on or below the debris-covered lower slope of the Mount."

Since the restudy of this fauna, considerable work has been done in the arctic Ordovician and in the light of the progress made Schuchert now holds that no Black River or Trenton time is present in the Silliman's Fossil Mount but that all is of late Ordovician or Richmondian time (personal conversation, September 19, 1940). Bassler also now favors the Richmond age for the entire formation.

AGE OF SILLIMAN'S FOSSIL MOUNT

The question at issue is whether the fossils from Silliman's Fossil Mount represent the Mohawkian (Black River and Trenton) or the Richmond or both. For an answer to or indeed for a clear understanding of the problem, it would be necessary to state the factors which have given rise to it. These are: (1) The fossils were not found in stratigraphic sequence except for a few gastropods belonging to the genera *Maclurina* and *Maclurites*, and a single cephalopod, *Westenoceras greggi*, which were collected *in situ* on the top of the mount; (2) the fossils suggest both Mohawkian and Richmondian age; and (3) correlation of arctic Ordovician faunas has largely been based on general similarities of faunas rather than on precise identifications of individual species.

Regarding the first factor, little can be said that would alleviate the difficulty. It is pertinent to mention, however, that no apparent lithologic difference is discernible among the beds of the mount. This may be verified in the exposure on the section behind the first front ridge (fig. 20, p. 41). The chemical analyses of the rocks (p. 43) also indicate that no significant difference exists among them other than what would be accounted for by slight changes in the condition in sedimentation. If there were two formations with several intervening ones missing, such as would be the case if a Richmond equivalent were laid upon a Trenton, some indication of the time that elapsed between the deposition of the two formations would be expected. No such record of an erosion interval is visible. It is, however, not implied that the absence of an erosional unconformity and the lack of lithological or significant chemical change prove definitely that the beds are of the same age, but this evidence nevertheless favors such an interpretation.

The second and third factors mentioned above are inter-related and it is desirable to treat them together. Much of the uncertainty that now exists regarding the age of the fauna of Silliman's Fossil Mount and of certain other closely related Ordovician faunas described in comparatively recent times from arctic America, central Canada, northern Alaska, and western United States, could be eliminated if the age of the fauna of the Red River formation of southern Manitoba were definitely settled. The latter fauna is strikingly similar not only to the fauna of Silliman's Fossil Mount but also to those from other localities cited above. The Red River fauna, therefore, as has already been indicated by Foerste (1929, p. 138), promises "to serve as a key in the solution of uncertainties in stratigraphy presented by those areas in which the opportunities for determining the stratigraphic sequence of the different faunas are less favorable."

The Red River formation occurs on the west shore of and on the island in Lake Winnipeg in southern Manitoba, and in the adjacent part of the Red River Valley. D. B. Dowling (1900) divides the Ordovician beds of this area into the following formations:

	Stony Mountain formation						
[Red River formation of Foerste]	<table style="border: none; border-left: 1px solid black; border-right: 1px solid black;"> <tr> <td style="padding: 0 5px;">{</td> <td style="padding: 0 5px;">Upper Mottled limestone [=Selkirk limestone of Foerste]</td> </tr> <tr> <td style="padding: 0 5px;">{</td> <td style="padding: 0 5px;">Cat Head limestone</td> </tr> <tr> <td style="padding: 0 5px;">{</td> <td style="padding: 0 5px;">Lower Mottled limestone [= Dog Head limestone of Foerste]</td> </tr> </table>	{	Upper Mottled limestone [=Selkirk limestone of Foerste]	{	Cat Head limestone	{	Lower Mottled limestone [= Dog Head limestone of Foerste]
{	Upper Mottled limestone [=Selkirk limestone of Foerste]						
{	Cat Head limestone						
{	Lower Mottled limestone [= Dog Head limestone of Foerste]						
	Winnipeg sandstone						

As indicated above, Foerste (1928c, p. 26) proposed the names Selkirk limestone for the Upper Mottled limestone, and Dog Head limestone for the Lower Mottled limestone. He also proposed the name Red River formation to include all three strata, Selkirk, Cat Head and Dog Head. These changes in nomenclature have gained adoption and the original names have become obsolete.

The Stony Mountain formation is composed of shales and limestones totaling about 100 feet. From these beds Dowling (1900, pp. 48F–53F) has listed sixty-two species, the majority of which occur in, or are restricted to, the accepted Richmondian strata. According to Dowling (p. 47F) the upper part of the Stony Mountain formation “is referable to the Richmond group of Minnesota,” and the lower beds “are similar to the Utica of the Cincinnati formation.” More recently, W. H. Twenhofel correlated the Stony Mountain formation with zones 3, 4 and 5 of the Vaureal member of the Richmond group as exposed on Anticosti Island. Thus there seems to be no question regarding the Richmond age of the Stony Mountain formation. The present problem is: What is the age of the underlying limestones, collectively called the Red River formation, and of the Winnipeg sandstone? Should they be regarded as Mohawkian or Richmondian?

The Winnipeg sandstone forms the basal member of the sequence. Of the twelve fossils described from it, four are common to the overlying beds. Dowling thought that the sandstone represented the upper part of the Black River formation but he was not certain. The fossils give no definite information. The sandstone may be the initial deposit of and of the same age as the Red River formation.

As to the Red River formation, J. B. Tyrrell (1892) correlated it with the Trenton. J. F. Whiteaves maintained the same correlation except that he thought that the formation holds “several fossils elsewhere supposed to be restricted to the Hudson River group.” (1897, p. 135.) He added that the relationship of the Red River fauna was closer to that of the northern part of the Mississippi Valley than that of New York, southern Ontario and other eastern areas. D. B. Dowling brought together all the information available at that time regarding the Red River fauna and correlated the Selkirk (Upper Mottled) limestone, the Cat Head limestone, and the Dog Head (Lower Mottled) limestone with the *Maclurea* beds, *Fusispira* and *Nematopora* beds,¹ and *Clitambonites* beds¹ respectively (Dowling, 1900, p. 35F). The above correlations remained virtually unquestioned for many years. The first suggestion that the Red River formation may be younger than the Trenton came from R. S. Bassler in 1915. In his list of Red River cephalopods he stated (1915, p. 1458): “This list includes the species from the Cat Head and associated formations in Mani-

¹ Divisions of the Trenton group in Minnesota.

toba. Although recorded as of Mohawkian age by Whiteaves, it is probable that many of them were derived from Richmond strata." Unfortunately, Bassler did not specify in his list any particular species which he considered to be of Richmond age.

Some years later, Foerste became interested in the age of the Red River formation and in the correlation of its different members with their equivalents in the Arctic and in the United States. A great deal of our knowledge of the arctic Ordovician faunas, the cephalopods in particular, is due to his labors. Speaking of his interest in the Red River fauna, he stated (1932, p. 53): "The Red River formation and its equivalent is one of the most remarkable of known Paleozoic formations on account of its enormous extension in a north and south direction, its range from northwestern Greenland to south-central Oklahoma equaling more than 3,100 miles, and extending from the most northern fossiliferous areas known in the Arctic to the southern part of the Temperate zone. The most southern outcrop of this Arctic invasion is in the El Paso area, in the extreme western part of Texas."

The first indication that Foerste suspected that the Red River formation might be of later age than Trenton is found in his statement (Foerste and Savage, 1927, p. 10): ". . . a considerable part of the genera found in the Winnipeg limestone [Red River formation] continue into strata whose Richmond age is unquestioned but which are located in other areas." In 1928, basing his statement on his studies of the cephalopods of Putnam Highland, southwestern Baffin Land, and on the studies of other elements of the faunas of equivalent age from elsewhere, he stated (1928, p. 32): "Our present knowledge of the cephalopods and corals appears to favor the Richmond age of the entire Red River formation, as exposed in southern Manitoba, and of the combined Shammattawa-Nelson section, as exposed in the area southwest of Hudson Bay." In 1929 Foerste expressed his opinion more clearly, as follows (1929a, p. 146): "The present problem is whether the Red River formation shall be regarded as of Trenton or of Richmond age. The answer will depend on the point of view of the investigator. Prevalence of a general Trenton facies suggests its Trenton age. The introduction of an important number of characteristic Richmond genera and species suggests its reference to the Richmond. The present writer favors the latter procedure." Again in 1929, in a discussion of the stratigraphic position of the Red River formation, he stated (1929, p. 47): "If the number of species having Mohawkian affinities be compared with those having Richmond affinities, the former will have the majority, and the Red River formation will then be regarded as Mohawkian—more specifically as Trenton. On the contrary, if the first considerable invasion of species having Richmond affinities into an otherwise Mohawkian fauna be regarded as indicating contemporaneity with Richmond strata, then the Red River fauna will be regarded as of early Richmond age. It is the second method of solution which here is adopted. Hence the lower Richmond age of the Red River fauna is accepted." In a later paper, however, he indicated that the Red River formation might be an inter-

mediate horizon, as can be deduced from the following statement (1932, p. 56): "While none of these Black River precursors¹ appear strictly identical with the Richmond faunas exposed in the Big Hill member of the Richmond, it is evident that intermediate forms must have occurred somewhere in those formations which intervene between the Black River and the Richmond, and that these intermediate forms are not known at present from any source, unless the Red River represent such an intermediate horizon."

A. K. Miller, in his discussion of the age of the basal or Lander sandstone member of the Bighorn formation, which is considered to be of the same age as the Red River formation, concluded (1930, pp. 203-204): "From the preceding discussion it is evident that although Black River and Trenton affinities are present in the fauna of the Lander sandstone, a considerable number of forms with Richmond affinities also occur here. Furthermore, although superficially the majority of the fossils would seem to support the traditional belief in a Mohawkian age, a critical examination of the available evidence seems to belittle the Mohawkian affinities. Also, since the Richmond fauna is a recurring Mohawkian fauna, Mohawkian forms should be expected in the Richmond, but the reverse would be difficult to explain. These facts have led the writer to the conclusion that the fauna of the Lander sandstone is of Richmond age."

G. Marshall Kay, on the other hand, favors Trenton age for the Red River formation. "The facts contributed in this paper lend support to a view that the Red River formation *may be* of Trenton age; and it is possible that the beds represent both the Prosser and Stewartville, the boreal element appearing in Manitoba in Prosser time, not becoming preponderant farther south until the Stewartville." (Kay, 1935, p. 589.) He, however, makes this reservation (p. 588): "One must conclude that the evidence is still not sufficient to demonstrate the age of the Red River unequivocally. Though the formation has a close faunal resemblance to the Stewartville, the species in many cases are distinct, and it may be added that forms from supposed Red River equivalents in the Arctic have also been specifically distinguished. There are a few forms that suggest Cincinnati age, and they may prove to be the most significant, but there are many more that characterize known Trenton formations." Kay's main contention, favoring Trenton rather than Richmond age for the Red River formation, seems to be based on certain faunal elements which have been regarded as evidence of Richmond age but which, or rather the like of which, also occur in the Trenton. The elements under consideration with Richmond affinities are four genera of cephalopods, *Billingsites*, *Ephippiorthoceras*, *Charactoceras*, and *Cyclendoceras*; one coral, *Halysites gracilis* (Hall), and three brachiopods, *Lepetaena unicastata* (Meek and Worthen), *Rhynchotrema capax* (Conrad), and *Dinorthis subquadrata* (Hall). Of the cephalopods, Kay cites one or more specific examples from the Trenton for each of the genera except *Billingsites* (none, however, is conspecific with a Red River species) and states (1935, p. 588): "Thus, of

¹ Certain corals described under the names *Calapoecia canadensis*, *Halysites catenularia* var. *quebecensis*, and *Columnaria rugosa*, from the Black River formation at Blue Point, north of Roberval, on the west side of Lake St. John, Quebec.

the cephalopods, *Billingsites* seems to be the single genus that is strongly suggestive of a post-Trenton age for the Red River formation." *Billingsites*, however, is not the only genus strongly suggestive of a post-Trenton age. The genus *Huronina*, represented by *H. occidentalis* Foerste, occurs in the Red River formation and is equally suggestive of a post-Trenton age.

As to the occurrence of *Halysites gracilis* (Hall) in the Stewartville, it may be reiterated, for the subject has been discussed at length on page 77, that the different species of *Halysites*, particularly those that are closely allied, are difficult to differentiate. Whether *H. gracilis* from the Stewartville is conspecific with the Red River species is not definitely known, for no comparative studies of the two forms have ever been made. But even assuming that the two species are conspecific, there remain *Calapoezia canadensis* Billings, *Columnaria stokesi* (Edwards and Haime) and *Palaeofavosites prolificus* (Billings) to be accounted for. Each of these three species suggests affinities with the Richmond and all occur in the Red River formation, but none is represented in the Stewartville.

Of the brachiopods, Kay states (1935, p. 588): "*Leptaena unicastra* (Meek and Worthen) seems of Cincinnati affinity, but the *Rhynchotrema* sp. in the Stewartville is more like *R. capax* (Conrad) than any other Trenton species; and *Dinorthis subquadrata* (Hall) is closely similar to the species in the Dubuque dolomite and to *D. iphigenia* (Billings) of the Lower Cobourg."

It is evident from the above statement that of the two brachiopods from the Stewartville, neither is conspecific with a Red River species—they are only closely allied. It may be brought to attention here that, in addition to the brachiopods referred to above, there are several other important Red River species of post-Trenton age, none of which is known from the Stewartville. These are: *Stropheodonta leda* (Billings), *Dinorthis proavita* (Winchell and Schuchert), *Platystrophia crassa* (Jones), and *Rhynchotrema anticostiense* (Billings). Other elements of the Red River fauna with Richmond affinities, not known in the Stewartville, are *Nidulites gregarius* (Billings), *Comularia asperata* Billings, and *Onchometopus susae* (Whitfield).

From the preceding paragraphs it is apparent that the evidences that Kay has brought forward in support of the Trenton age of the Red River formation is based not on conspecific forms but on a few closely allied species and on certain identical genera occurring in the Stewartville and the Red River formation. Precise identification of stratigraphic units demands precise identification of individual species. Hence, any attempt to correlate strata deposited in distinct basins by means of specific resemblances alone is subject to serious error. Likewise, there is danger in correlation based on the presence of congeneric forms, for many genera have long vertical range. That the Red River formation has a close faunal resemblance to the Stewartville is conceivable. Both faunas were originally of the same faunistic realm and the younger is likely to contain some "holdovers" from the older that are but slightly modified. Here the Red River fauna is regarded as younger, for it contains a considerable number of forms with Richmond affinities; the Stewartville does not.

To get a comprehensive understanding of the age of the fauna in the Red River formation it would be necessary to examine also the faunas which are regarded to be of equivalent age and which have been studied in comparatively recent times. Such an examination will bring to light those species which have not been recorded from the Red River formation but have been found elsewhere, and vice versa. The general distribution of the faunas of equivalent age has been mentioned above. More specifically, these faunas occur in northwestern Greenland, east-central and southern Ellesmereland, North Devon Island, Wellington Channel, Melville Island, North Somerset Island, Boothia Peninsula, King William Island, Igloodik Island, southeastern and southwestern Baffin Land, Southampton Island, Akpatok Island, southwest of Hudson Bay, Lake Timiskaming, Great Slave Lake, southern British Columbia, northern half of Alaska, western Wyoming, southwestern South Dakota, central Colorado, and parts of Montana, Idaho, Utah, Oklahoma, New Mexico, and Texas.

Of these localities only the more important ones—those from which comparatively large collections have been made—will be considered. Only those elements of the faunas with unquestionable Richmond affinities will be discussed, for the significant feature of the faunas under consideration is not the presence of a large number of species with Mohawkian affinities but the introduction of younger elements with strong Richmond affinities. It should be pointed out, however, that the Mohawkian fossils in the Red River formation are not nearly as common as was once believed. Miller lists twenty-five forms with Mohawkian affinities from the Lander sandstone (equivalent to the Red River formation) of Wyoming, of which only two, *Spyroceras olorus* (Hall) and *Beloitoceras plebium* (Hall), were identified; the remaining twenty-three of his specific identifications were qualified with “?,” “cf.,” or “aff.” This suggests that typical Mohawkian forms are rare and that the great majority of them have undergone modifications. The same is true of the present collection. Not a single form was found to be conspecific with a known Mohawkian species. When compared with specimens of definite Mohawkian age, the Silliman’s Fossil Mount forms showed slight but distinct differences. Foerste, in speaking of Dowling’s list of fossils (Dowling, 1900, pp. 48F–53F) from the Red River formation, remarked (1928, p. 32): “In this list, various species have been identified with characteristic Trenton and Black River forms, in my opinion erroneously.” At the time the identifications were made, the mere presence of a large *Receptaculites* or a large *Maclurina* was considered sufficient evidence for Mohawkian age. In other words, identifications usually were made on preconceived notions as to the age of the fossils, in consequence of which slight specific differences that might have existed were overlooked. This has been very clearly stated by Schuchert:¹ “In 1900, no one knew these ‘sunflower corals’ in other than middle Ordovician formations, but in recent years they have been shown to occur also plentifully in late Ordovician faunas from Manitoba to northwest Greenland. This increase of knowledge, together with an extension of the range of the corals and of the gastropod,

¹ Quoted by permission from unpublished manuscript.

Maclurina manitobensis, has led to the discovery that the Richmondian faunas are of the widest distribution in Arctic America. This view is further strengthened by the cephalopods." Foerste (1924, p. 17) quotes Ulrich as stating that "the Richmond of Alaska and the western states contains a species of *Receptaculites* so similar to *Receptaculites oweni* that it has been distinguished only recently." With regard to *Maclurina*, he further quotes Ulrich as stating that "the Stewartville member of the Trenton contains fossils that have been identified with Manitoban fossils (notably *Maclurina manitobensis* and *Receptaculites oweni*), but are not precisely similar." Several specimens of *Maclurites* and *Maclurina* in the present collection were found *in situ* at the top of the Fossil Mount, whereas all the cephalopods, except *Westenoceras greggi*, and all the corals having distinct Richmond affinities were collected from talus slopes which were obviously the result of disintegration of lower beds. It is evident, therefore, that the gastropods *Maclurites* and *Maclurina* are no older than the other groups. Thus the following statements seem to be invalid: "The Baffin Land fauna had an early introduction of Upper Silurian (Richmond) genera in the corals *Halysites*, *Lyellia*, and *Plasmopora*" (Schuchert, 1900, p. 175); and "The geologic section at Baffin Land consists of Black River strata resting upon the old crystalline rocks, followed by an early Trenton formation equivalent to the Stewartville and Prosser limestones of Minnesota, and this in turn succeeded unconformably by the widespread coral zone of the Richmond group." (Bassler, 1911, p. 36.)

LIST OF SPECIES REGARDED AS OF RICHMOND AGE

M=Red River formation, southern Manitoba; B=Frobisher Bay beds, Baffin Land; G=Cape Calhoun beds, Greenland; and W=Lander sandstone, Wyoming.

<i>Nidulites gregarius</i> (Billings)	M
<i>Streptelasma rusticum</i> (Billings)	G
<i>Streptelasma robustum</i> Whiteaves	M, B? G, W
<i>Columnaria stokesi</i> (Edwards and Haime)	M, G
<i>Paleofavosites prolificus</i> (Billings)	M
<i>Calapoecia canadensis</i> Billings	M
<i>Calapoecia canadensis ungava</i> Cox	G
<i>Calapoecia canadensis anticostiensis</i> Billings	B, G
<i>Calapoecia canadensis anticostiensis</i> f. <i>arctica</i> Troedsson	G
<i>Plasmopora lambei</i> Schuchert	B, G
<i>Plasmopora pattersoni</i> Roy	B
<i>Lyellia affinis</i> Billings	B
<i>Halysites gracilis</i> (Hall)	M, B, G, W
<i>Halysites agglomeratiformis</i> Whitfield	B, G
<i>Syringopora conspirata</i> Troedsson	G
<i>Ptilodictya flagellum</i> Nicholson	G
<i>Monticulipora parasitica plana</i> Ulrich	G
<i>Rhombotrypa subquadrata</i> Ulrich	G
<i>Dinorthis subquadrata</i> (Hall)	M, W?
<i>Dinorthis proavita</i> (Winchell and Schuchert)	M
<i>Platystrophia crassa</i> (Jones)	M
<i>Austinella cooperi</i> Roy	B

<i>Rafinesquina lata</i> Whiteaves.	G, W
<i>Strophomena fluctuosa</i> Billings.	G
<i>Strophomena plandorsata</i> (Winchell and Schuchert).	G, W
<i>Leptaena unicastata</i> (Meek and Worthen).	M, G?
<i>Rhynchotrema capax</i> (Conrad).	M, B? G, W?
<i>Rhynchotrema anticostiensis</i> (Billings).	M, B, W?
<i>Maclurites acutus</i> (Parks).	G
<i>Conularia asperata</i> Billings.	M
<i>Endoceras fulgur</i> (Billings).	B? W
<i>Billingsites costulatum</i> (Whiteaves).	M
<i>Charactoceras baeri</i> (Meek and Worthen).	G?
<i>Wilsonoceras mccharlesi</i> (Whiteaves).	M
<i>Apsidoceras elegans</i> Troedsson.	G
<i>Huronina occidentalis</i> Foerste.	M
<i>Homotelus gratiosus</i> Raymond.	G
<i>Onchometopus susae</i> (Whitfield).	M
<i>Ceraurinus icarus</i> (Billings).	B? G
<i>Primitia cincinnatiensis</i> (Miller).	B

The above list is taken from only four out of at least thirty localities and, therefore, is much short of the total number of species with Richmond affinities known from beds equivalent to the Red River formation. Moreover, the list does not include the numerous new species with Richmond affinities described in recent times, or the equally numerous forms that have been identified as closely allied to Richmond species. If all these species were considered, the total number would be quadrupled at least. The question now may be asked: Where did they come from? Why are they not present in the Mohawkian of the Mississippi Valley or in the Mohawkian of New York, southern Ontario or other eastern areas? It would hardly be convincing to attempt to answer these questions by simply stating that they are but an early introduction of younger elements in an otherwise older or Mohawkian fauna. The number of Richmond species is far too large to favor such a conclusion. The inescapable answer is that the Red River fauna and its equivalents, which include the Silliman's Fossil Mount fauna, are post-Mohawkian, or of early Richmond age.

The presence of Mohawkian forms, as has been mentioned previously, is due to the fact that the faunas under consideration are a recurring Mohawkian fauna. The recurrence may be explained by assuming that during Eden and Maysville times the Mohawkian forms retreated to northern waters where they existed until they replenished the Richmond seas which progressively spread southward from the Arctic over the northern half of Alaska, much of Canada, British Columbia, across west-central United States down to Texas. In general, this is true of the northern Richmond invasions. The Richmond faunas of southern origin invaded the continent by way of the Gulf of Mexico. Some of these southern faunas were "originally of northern origin, but during Eden and Maysville times gradually extended their ranges southward, so that when the southern Richmond invasion took place they were able to enter the Mississippi embayment, and progress as far north as Ohio, and later, southern

Canada." (Foerste, 1924, p. 45.) Based chiefly on the studies of Ulrich, Schuchert and Foerste, the last-named author has ably summarized the diastrophic changes which were responsible for the recurrence of Mohawkian fauna and the distribution of the Richmond faunas of both northern and southern origin, as follows: "During Black River and Trenton times the North American continent was apparently tilted so as to admit epicontinental seas, chiefly from the north. During Eden and Maysville times it appears to have been tilted in an opposite direction. Northward tilting brought in again the Black River and Trenton faunas during Richmond time. Of course, events were not altogether as simple as suggested by these statements. Epicontinental seas deriving their faunas from different sources were no doubt present on different parts of the continent at the same time. The invasions that extended over the wider areas were probably due to tiltings that more or less excluded faunas from other directions. It is unlikely, for instance, that the major northern Richmond invasions were strictly contemporaneous with the major southern Richmond invasions. Although it is possible to determine their relative ages only where they overlap, their approximate age may be determined even when the strata are nowhere in contact." (Foerste, 1924, p. 46.)

The above statements afford the basis to conclude clearly that the Silliman's Fossil Mount fauna and its equivalents are a recurring Mohawkian fauna of early Richmond age. The facts that the elements with Mohawkian affinities in these faunas are rarely conspecific with typical Mohawkian species and that these faunas contain a considerable number of unquestioned Richmondian forms are alone sufficient evidence to arrive at such a conclusion. That in a recurring fauna there should be a strong similarity of the major portion of its elements to the older forms is not only to be expected but is also in accord with our present conception of organic evolution. Knowledge of these "holdovers" and the relative stability of certain species serves as a useful reminder of the possibilities of error inherent in age determination by percentage composition method alone.

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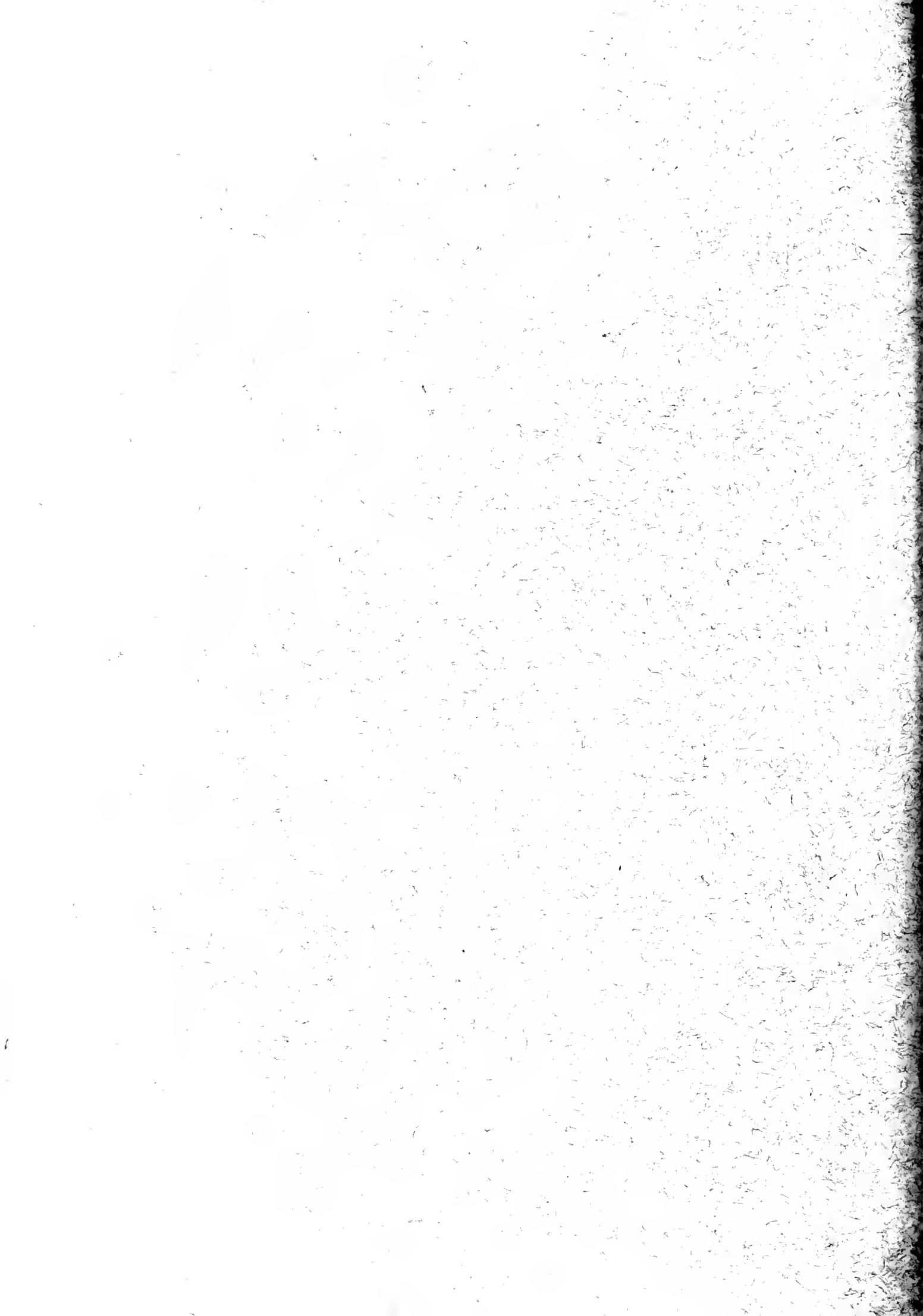
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